

computing today

ISSN 0142-7210

DEC 1979

50p

**HUBBLE BUBBLE
TOIL AND... AIM 65?**

PET Impressions

Life For Nascom

MMGU To Build

Index 79



8K ON BOARD MEMORY!

5K RAM, 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

2 KEYBOARDS!

56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code.

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low error rate tape interface.

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POWERTRAN

PSI Comp 80.Z80 Based powerful scientific computer
Design as published in Wireless World April — September 1979

The kit for this outstandingly practical design by John Adams being published in a series of articles in Wireless World really is complete!

Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

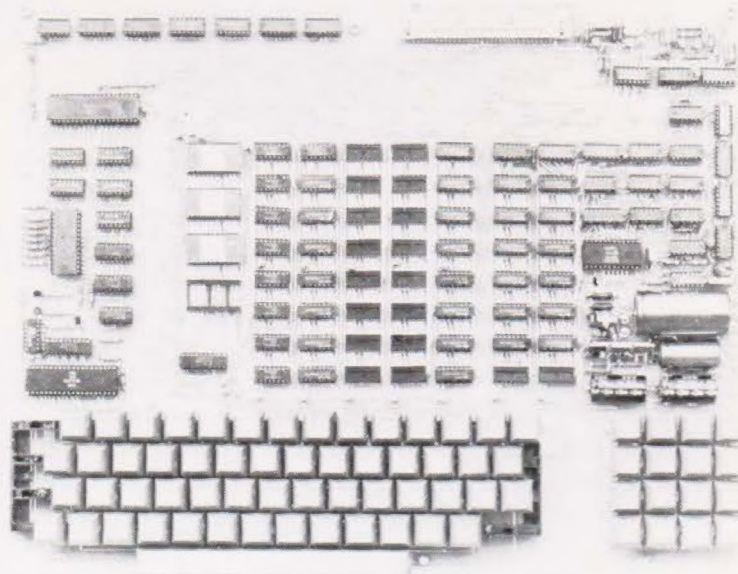
PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!

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	2114L RAM (16 required)	£5.00
	Complete set of board, components, 16 RAMs	£89.50
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	Set of components including IC sockets, plug and socket but excluding ROMs	£10.70
	2708 ROM (8 required)	£8.00
	Complete set of board, components, 8 ROMs	£78.50

Floppy Disk, PROM programmer and printer interface coming shortly!



PCB size 16.0" x 12.5"

Value Added Tax not included in prices

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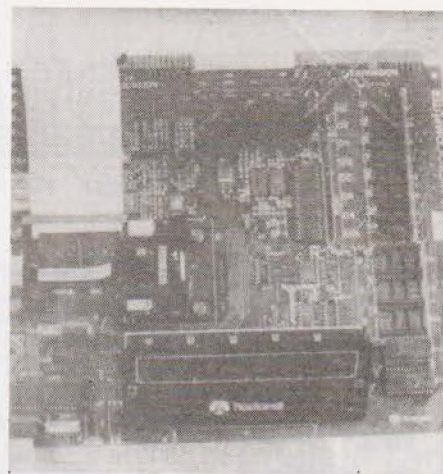
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interface

NASCOM's NEW BIG DISTRIBUTOR

NASCOM-2 + FREE 16K RAM

Here's an offer you can't refuse:

Because of the lack of availability of MK 4118 RAMs, Nascom Microcomputers is supplying its Nascom 2 without the 8 spare 4118s but with a FREE 16K dynamic RAM board.

When the 4118s become available, Nascom 2 purchasers can have them at the special price of £80 + VAT for the 8K.

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MICROPROCESSOR

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NASCOM SOFTWARE

8K BASIC tape: £15.00 + VAT



NASCOM-2 + FREE 16K RAM
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No more slaving over a hot soldering iron - the Nascom 1 is now supplied BUILT!
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nascom-1

12" x 8" PCB carrying 5LSI MOS packages, 16 1K MOS memory packages and 33 TTL packages. There is on-board interface for UHF or unmodulated video and cassette or teletype. The 4K memory block is assigned to the operating system, video display and EPROM option socket, leaving a 1K user RAM. The MPU is the standard Z80 which is capable of executing 158 instructions including all 8080 code.

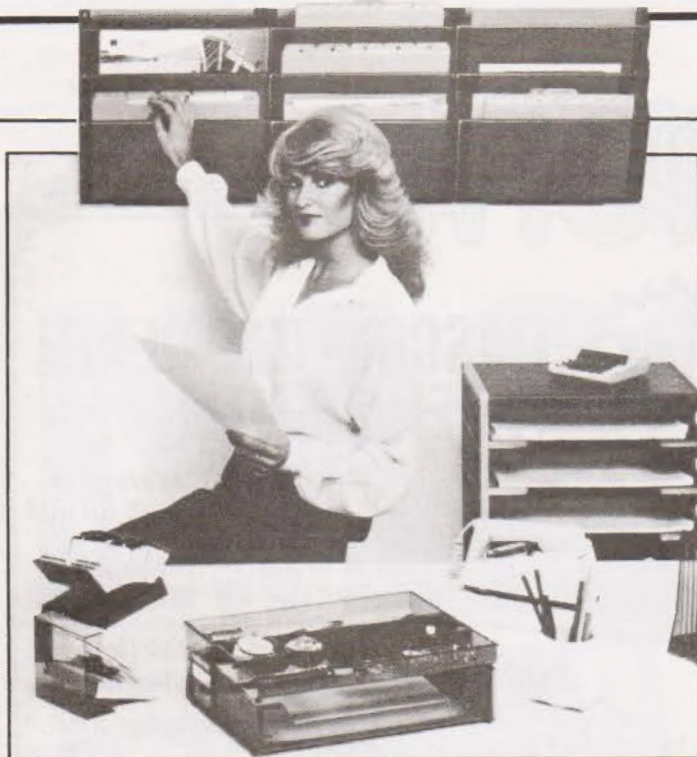
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+P&P
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NASBUG T2: £12.50 + VAT + 30p P+P
NASBUG T4: £25.00 + VAT + 30p P+P
NAS-SYS 1: £25.00 + VAT + 30p P+P



HANG IT ON THE WALL

Ideal for the home study, workshop or computer room is a new product from Eldon. Called the Super Hot File (?) it's a wall mounting filing system that will hold anything from computer printout to your latest copy of CT with consummate ease. You start with a basic filing pocket and three add-on pockets and expand to your hearts content, limited naturally by the size and strength of your wall. Each pocket measures a generous 400 by 229 by 38 mickey mice and is hung up with either sticky pads (dodgy) or screws and plugs (much better). A full colour leaflet extolling the virtues on Eldon's range of office requisites can be obtained by dropping a line to Eldon Office Products (Europe), Unit 3, Clifton Road, Shefford, Bedfordshire MK43 8AS. I wish I could remember her name . . .

PAT ON THE BACK TIME

Back in August we announced that Microdigital were producing a series of utility boards for the Nascom. Well the first of that range has just been announced and will be available in mid-October. Priced at £49.95 the board holds 16 reed relays with 200 mA, 50 V (DC) capability, is ss glass fibre with gold plated edge connectors and can be hung on the Nasbus direct. Power required is a meagre 250 mA from both the +5 and +12 volt rails. All the IC's are socketed and the device is addressable to any two consecutive ports by links, hence you can use several on one system. Envisaged for use in control situations such as industrial processes, model railways, robots etc., the unit is supplied with sample software. Microdigital live at 25 Brunswick Street, Liverpool L2 0BJ.

FORTHING AT THE MOUTH

Julian Allason of Petsoft reports:

During a recent visit to California, I paid a visit to Programma Inc., one of the largest American micro software houses. I found them hard at work on a micro-version of the FORTH language. Programma Inc., are a new company who in just six months have elbowed their way to the front of the micro software scrum. What had brought me 6,000 miles from Berkshire was a rumour that someone had developed a version of the FORTH language for micros.

FORTH started as a relatively obscure language for minis, developed at the U.S. National Radio Astronomy Laboratory. Yet in the short while since Charles H. Moore had first described his new baby in the Journal of Astronomy and Astrophysics, it has achieved almost cult status. Its main features are speed and its characteristics as a user-defined language. And that was about the limit of my knowledge! After vigorous handshaking, I was led down several flights of stairs into a brightly lit office in the bowels of their building. There, surrounded by microcomputers of every description, I received an introduction to Micro-FORTH from the man who developed it.

"FORTH is a unique threaded language ideally suited to micro computers", explained Mel Norrell. Programs written in 6502 FORTH are very compact; in 10K bytes the user might have the interactive FORTH compiler/interpreter running stand-alone using the system's monitor for I/O, and other routine routines, plus an incremental assembler, cassette memory software and a text editor. "All of this in 10K?", I asked. "Yes — and about 80% of it would be written in FORTH" replied Mel. It would also run in the same space with no additional symbol table area, overlays, swapping or use of any other software.

Typically, software development time is halved, in comparison with assembly language work. All programming is done in a structured manner — there is no GOTO for example — and the resulting code is re-entrant and can be designed for PROM. "That is all very well", I said, struggling to keep myself afloat as the author, clearly a graduate of the IBM Academy of Systems Design, plunged deeper into conceptual territory. "But how do you actually use it?"

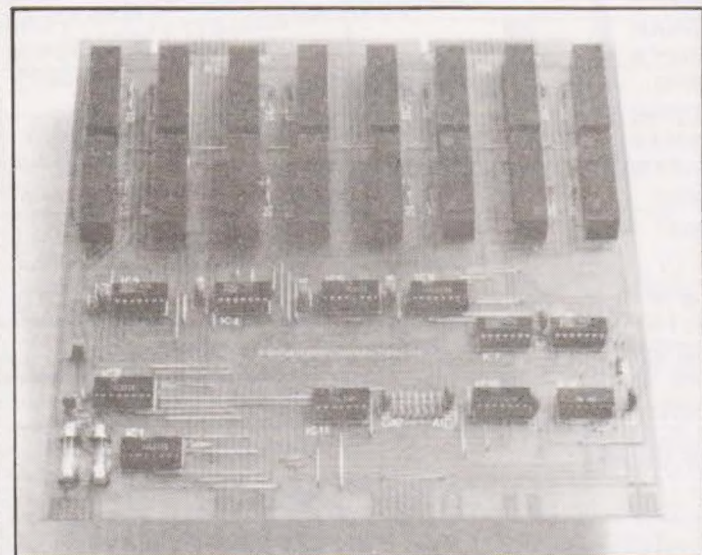
The basic element of the FORTH system is a "word" which would be roughly equivalent to a subroutine in BASIC. When referenced, the word causes a specified action or sequence of actions to be performed. Before a word can be executed and the particular subroutine called, the word itself must be defined and stored in the 'Dictionary'. The 6502 FORTH Dictionary initially contains some 200 words, which make up the standard vocabulary. The beauty of the system is that the user can effectively create his own language by using some of the standard words to define new ones. These can then be saved, so that the user has his own unique language on hand for instant use. Any sequence of characters can be used to define one of the new words with the exception of reserved words which have special meaning for the machine code environment being used. Each word must be separated from another by a space or blank. Control is passed to the system for execution when 'Carriage Return' is pressed. For example:

7 3 + . CR

will add the numbers 7 and 3 together, printing a 10 if the system has been set to decimal or A if it is in hexadecimal mode.

Reverse Polish Notation and Last-in First-out stacks are used. In the example above, the number 7 was pushed into the stack, followed by the number 3. Both numbers were added and "popped" off the stack by the previously defined word "+". The result, 10, is "pushed" onto the stack by the "+" operation also. The word "." then "pops" the stack to its initial condition and prints the number 10 on the screen or printer. To conserve memory, only the first four characters are stored. If a word typed into the input stream cannot be located in the dictionary, the system attempts to treat it as a number, and convert it to binary. If the word does not match the proper format and base, an error message is generated.

Some of this may sound a little strange, particularly to those whose experience is limited to high level languages such as BASIC. However, I did talk to a couple of people who had purchased 6502-FORTH, and both were delighted. So it seems that once you have got used to using the standard vocabulary, Micro-FORTH can be used for some very creative computing indeed. As for me, well, I am working on it.



RAM SAVER

If you have that burning desire to protect your memories in the event of the Electricity people forgetting to put the kettle on you will be interested to learn of these new batteries. Made out of Lithium Iodine they are very tiny, as you can see, and offer a very high reliability as well as PC mounting. They will last for at least ten years and you can do all sorts of nasty things to them without upsetting their delicate little bodies. You have a choice of two sizes, both 2V8 460 mA hours and 870 mA hours to suit your application. For further details on these little wonders contact Mine Safety Appliances Co Ltd., Blairtummock Road, Queenslie Industrial Estate, Glasgow G33 4BT or ring them on 041-774 5111.

BRITISH IS BEST, PT 2

If you want to win a rather substantial sum of money, and who doesn't, you could have a bash at entering your micro-based doobry or whasit in the British Microprocessor Competition. Sponsored by both the NCC and the NRDC it is open to UK residents or registered organisations and companies who wish to submit their microprocessor based invention, which must not be in full scale production. The prizes are in two categories, the working model section with a £10,000 first prize and the non-working model section with a first prize of £2000. As well as the actual loot the NRDC will consider investing up to £500,000 in any of the winning entries. Entries must be submitted by the 14th of December on the official entry form which is available from The British Microprocessor Competition, c/o The National Computing Center Limited, Oxford Road, Manchester M1 7ED.

BRIDGING THE GAP

Bored with beating your neighbours each week at the Bridge Night? Well you can now tackle a little box instead. It allows up to three players to play either with or against itself, or it will play all four hands in demonstration mode, cunning huh? It uses the International points system and caters for European, American and ACOL bidding systems with its two micro's. It arrives in a hardwood box with an alphanumeric keypad and large display, gracing any coffee table, and uses an optical scanning method to look at the special cards and keep the players up to date on the state of play. You can even set it problems to solve. The cost is rather high, £299.95 so you may have to win quite a few rubbers to afford one. The game can be seen at Harrods, where else, and more gen is obtainable from Computer Games Ltd at 48 Cambridge Road, Barking, Essex.

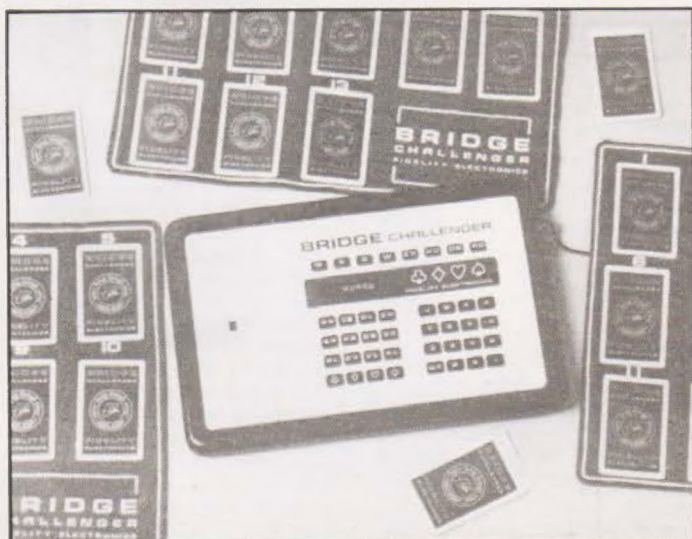


BEGGING YOUR PARDON

Some slight omissions from a November issue. We apologise profusely to both Malcolm Bell who wrote the Number Cruncher project and also to Iolo Davidson who contributed the Triton Typecast article. Owing to oversight, glasses have been issued, their names got left off. Credit should also have been given to the 20th Century Fox people for kindly letting us use photos from Alien for our review, and also to Heals for the loan of the bed for our October cover. All offenders are wearing sackcloth and ashes.

MORE HARD NEWS

Memorex have jumped into the hard disk market with an 8" unit for the small system. The new model 101 uses Winchester technology and holds 11.7 Mb on two platters. By using a direct drive technique such problems as belt and bearing wear have been eliminated, reducing part count and increasing reliability. Price for the unit in quantity is around \$1,560 and shipments will start in early 80. For technical detail contact Memorex UK at Staines, Middlesex.



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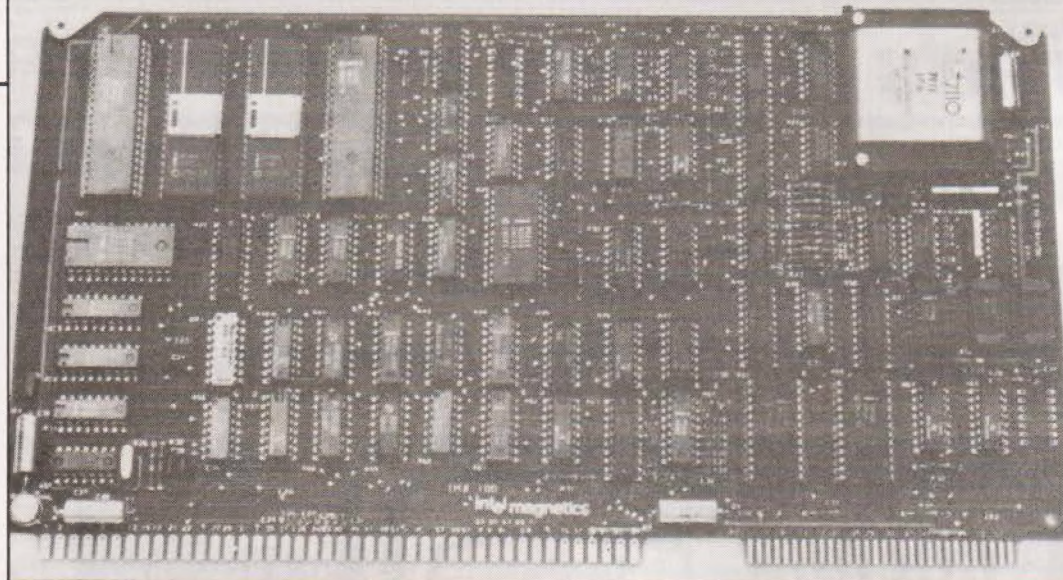
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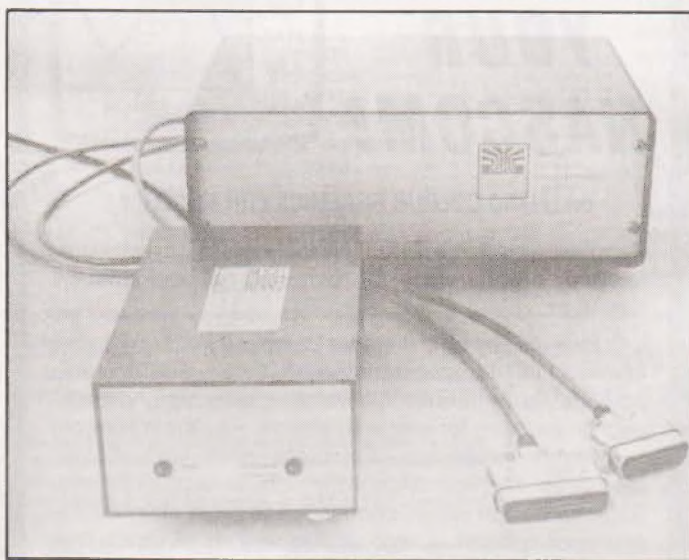


BUBBLING FURIOUSLY

Following on from our cover this month comes more news on bubble memory systems. Intel have just produced a 1Mb board for use with their Inteltec development systems or any other which uses the Multibus. The board is controlled by an 8085A which is built in and handles all the I/O routines. Along with the board you get a set of test routines on floppy to check out the system. Power requirements for the product are + and -12 and +5 volts. Further data is available from Intel at 4 Between Towns Road, Cowley, Oxford OX4 3NB.

INTERFACE PROGRAMMABLY

Small Systems Engineering, the electronic associate of Abacus Computers have just announced their latest offering for the micro world. Designed to link any IEEE-488 protocol device to the parallel or serial peripheral you wish to use it incorporates a Picoprocessor, programmed to handle the interface requirements. Costing around £120 it should offer an alternative method to those laborious hours with that soldering iron. Also on the way soon will be a version of their Stunt Box with an 8K BASIC included, making it into a programmable interface within a single board computer. Contact Small Systems at 62 New Cavendish Street, London W1M 7LD.



BRITISH IS BEST

A copy of the E78 Microcomputer Bus Specification floated gently onto my desk this week. Gently is not quite the right word for this is a very 'heavy' document. Born out of a desire to produce a true standard Bus it has been considerably tidied-up from the first attempt a year ago and is now the definitive work as far as the homebrew enthusiast goes. Whether our computer industry will accept it is another matter, remember BS4421? However there is an E78 to Nascom interface under development so perhaps someone will take it up and end the saga of the S100 et al. To obtain a copy of this reference work send £2.50 to The Microcomputer Bus Standards Committee, Avante House 9 Bridge Street, Pinner, Middlesex HA5 3HR if you are in the UK or £3.05, £3.15, £3.25 for airmail zones A, B and C respectively. Remember, if the hobbyist accepts it the manufacturers will hopefully follow suit.

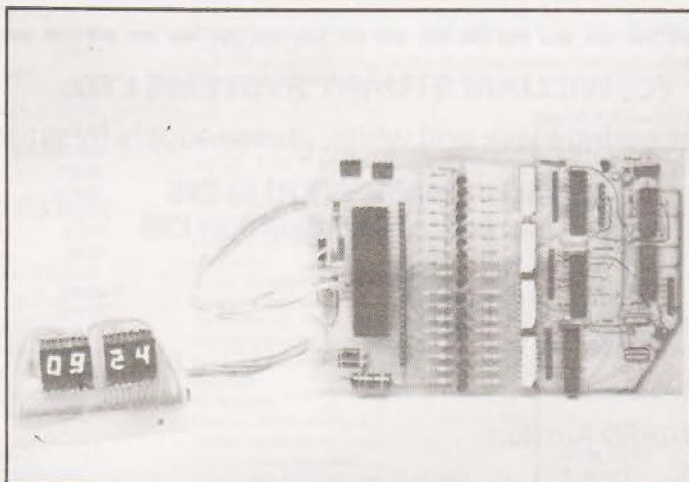
CLOCK THIS ONE

How often have you forgotten the time whilst bashing away at your computer keyboard? Quite often I bet. Well your troubles with your loved one over all those missed dates, late nights/early mornings and being locked in at work could be over. Auto-systems Development of Crossland Hall, Netherton, Huddersfield have released a clock-calendar module to slap onto your micro, saving you all the trouble and worry of writing a program to give you a nudge at bedtime. The module has LED displays for direct visual access as well as giving two digit serial BCD output via a tri-state buffer, selective output by code input and is available in either 12 or 24 hour versions. The calendar is programmed for four year cycles and the unit runs off the mains timebase although a crystal alternative will shortly be available. Imagine, at the top of every listing you have the time and date, never get mixed up again with yesterdays version of your Womp Rat Shoot..... For more info write to the above address or give them a bell on 0484-665111.

SIXTEEN FOR \$100

Now available from U Microcomputers of PO Box 24, Northwich, Cheshire is a sixteen bit processor card for the S100 bus. Based on the 8086 CPU it is fully compatible with the proposed IEEE standard, can address up to a Megabyte and is capable of running at up to 8MHz. It can be used with your

existing eight bit memory and peripherals, saving a fortune in new hardware, and has a support card which includes a 2K monitor, disk bootstrap, selectable baud rate and other necessary bits and pieces. A Microsoft BASIC will soon be available as well as CP/M. For more detail contact U Microcomputers at the above address.



COLOUR COMES TO SUPERBOARD

The colour graphics system from William Stuart Systems is now available for your Superboard. Using Pixel graphics, made up of individual addressable dots, it is capable of eight colours for foreground and background. Text can be interleaved with graphics to annotate graphs etc., in any of the available colours. Supplied as a kit complete with software routines it interfaces directly to a colour TV without affecting your normal video output. Access to the system is directly through BASIC using a CALLPOINT/LINE command and problems with the 50/60 Hz timebase are overcome with a simple mod. For more details contact William Stuart Microsystems at Dower House, Herongate, Brentwood, Essex.

Hundreds Already in Use!

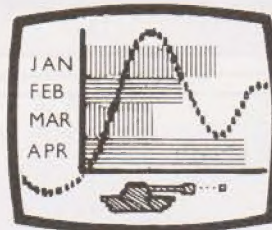
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DAZZLING COLOUR GRAPHICS FOR NASCOM 1

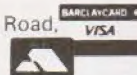
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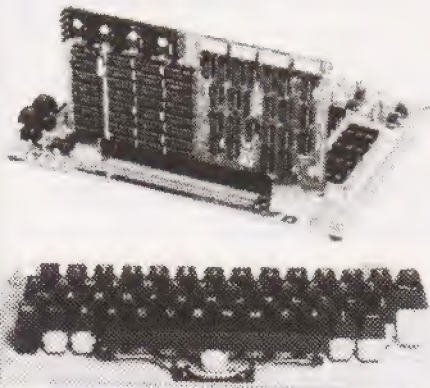
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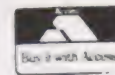
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A personal account of an endeavour to construct a machine with intelligent capabilities

The project which follows originated some years ago as the result of a determination to build a true 'electronic brain', as computers were referred to in the Press at that time, but it was held in abeyance until recently due to cost. The project was to have been a parallel processing special purpose machine with all hard wired logic. However, on recently reconsidering some of the criteria it was concluded that the use of microprocessors and their associated hardware would result in a machine that would require a smaller initial outlay and be far more open-ended.

The Theory Of Simulation

The central nervous system of any animal, from worm to man, consists of a network of special cells with some of the cells connecting to receptors (input) or effectors (output).

For the purposes of the exercise let us consider one of these cells as being a 'Black Box' of unknown function with a number of inputs and a single output. If we further assume that this cell functions in a binary manner, we can then apply Boolean algebra to its function. For a Black Box of N inputs the total number of functions possible is $2*(2^N)$ which in the case of a single input cell are as shown in Table 1. (See Table 2 for those for a two-input cell.)

Table 1

I/P	f0	f1	f2	f3
0	0	1	0	1
1	0	0	1	1
A	0	\bar{A}	A	1

Similarly all the possible functions for three and four input cells could be defined. If the simulation is programmed on the basis of one routine per function the processing becomes inordinately slow and complex. Fortunately this can be simplified thus, for a two-input cell, any function can be generated from the terms AB, $\bar{A}\bar{B}$, $\bar{A}B$ and $A\bar{B}$ (maxterms)¹ by selectively ORing them together.

$$\text{ie. } A = AB + A\bar{B} \\ A + B = AB + A\bar{B} + \bar{A}B$$

So we now need to selectively generate these maxterms and the function of a cell can be written

$$F_1 = S_0 A + S_1 \bar{A}$$

$$F_2 = S_0 AB + S_1 A\bar{B} + S_2 \bar{A}B + S_3 \bar{A}\bar{B}$$

$$F_3 = S_0 ABC + S_1 AB\bar{C} + S_2 A\bar{B}C + S_3 A\bar{B}\bar{C} +$$

$$S_4 \bar{A}BC + S_5 \bar{A}B\bar{C} + S_6 \bar{A}\bar{B}C + S_7 \bar{A}\bar{B}\bar{C}$$

Where S_n is the function selector.

Similarly for the sixteen terms required to define the function of a four-input cell.

Cell Networks

We now have a network of cells all linked together somehow but we also require it to have some connection to its environment. If we consider Tables 1 and 2 we see that there are in each two apparently trivial conditions where the output is unrelated to input and is always zero or one respectively. These are extremely important for two reasons:

- 1, In an evenly distributed randomly connected cell population these would block the logic chains preventing them becoming too large.
- 2, As a result of their being at the end of the chains we shall use them as the output cells of the network. Needless to say we shall have to modify their function if there is to be a meaningful output.

As the outputs of these cells are now connected elsewhere we shall use any input, which would have connected to them as an external input.

We can now economically define the functions of the cells and how the network connects to its external environment.

Table 2

I/P 1 (A)	0	0	1	1	
I/P 2 (B)	0	1	0	1	=
f0	0	0	0	0	0
f1	0	0	0	1	A.B
f2	0	0	1	0	A. \bar{B}
f3	0	0	1	1	\bar{A}
f4	0	1	0	0	A.B
f5	0	1	0	1	B
f6	0	1	1	0	$A \oplus B$
f7	0	1	1	1	$A+B$
f8	1	0	0	0	$\bar{A}.\bar{B}$
f9	1	0	0	1	$A \oplus \bar{B}$
f10	1	0	1	0	\bar{B}
f11	1	0	1	1	$\bar{A}.B$
f12	1	1	0	0	\bar{A}
f13	1	1	0	1	$\bar{A}.\bar{B}$
f14	1	1	1	0	$A+B$
f15	1	1	1	1	1

Let us now consider the effect of using serial as against parallel processing:

Parallel Processing Is Faster!

So it may be, but consider. A well trained human reaction time is 1/10 second, — watch fencing to see how fast that is! An MPU with 2MHz clock runs through 100,000 cycles in

that time. Let us assume that to process each cell, on average, requires 20 instructions taking 10 cycles each. That gives us 500 cells processed in 1/10 second, — a worm with fast reactions?

A micro does process in parallel; 8 bits at a time, although the same processing is applied to all of them. Our worm is therefore somewhat brighter and handling 2000 bits of (internal) information in a very reasonable time.

Using bytes also confers upon the "Intelligence" the ability to have a grey or shaded perception. It is suggested that, if bits are used as a switch type input, no byte contains data from unrelated sources.

Construction And Expansion

Personal computers are now easy to come by ready built or as kits, whereas a parallel machine would have to be hand built. A parallel machine would need to be rewired, whereas an MPU just requires more store with program changes to cater for it.

The hard storage of training data is far easier with a micro enabling the machine to be switched off without the need to retrain from scratch. This also enables the training to be passed more readily between machines.

The project is envisaged as developing through the following, possibly overlapping, phases.

Phase One

This is the minimum system requiring 2½K of store, plus whatever is required for the programs, and uses only two-input cells. The programs should preferably be written in Assembler as this would execute faster than Basic, etc.

The following programs are required and should need little amendment for larger systems.

1. A program to clear the storage mentioned above prior to the first run on any run where the size of this store is increased. If your monitor has a store checking routine which leaves the store as '0' this would be suitable.

2. PROCESSOR. This program reads in the tape containing the 'operand' and 'function' areas, defined below, from the previous run and then proceeds to simulate the function of the cells. There is some data needed by the 'Tutor' which is also required for each run, but as this is only four bytes it is easier entered manually. The program requires the following work areas in store.

a. Input and Output areas. Two areas in store for communication with the outside world, the size of which is determined by the number of cells whose output is always 0 or 1. In the case of two-input cells with a random distribution of function this is 1/8 of the total number of cells, here 32 bytes each.

The logic applied to determine what is moved between the I/O areas and the 'operand' areas is as follows:

I. The relative addresses of the I/O bytes within their respective areas is 1/8 of the output 'operand' relative address. This is a maximum, the program may or may not use all of it.

II. The 'input' byte is moved to the byte pointed to by the output 'operand' address.

III. The exclusive — OR of the input 'operands' is moved to the 'output' byte. The exclusive —OR is arbitrary; any other function would do as well.

b. Operand area. This area stores the output of the cells so that other cells may access them for use as input. In this case:—

$32 \times 8 = 256 \text{ bytes} \equiv 256 \text{ cells}$
are required.

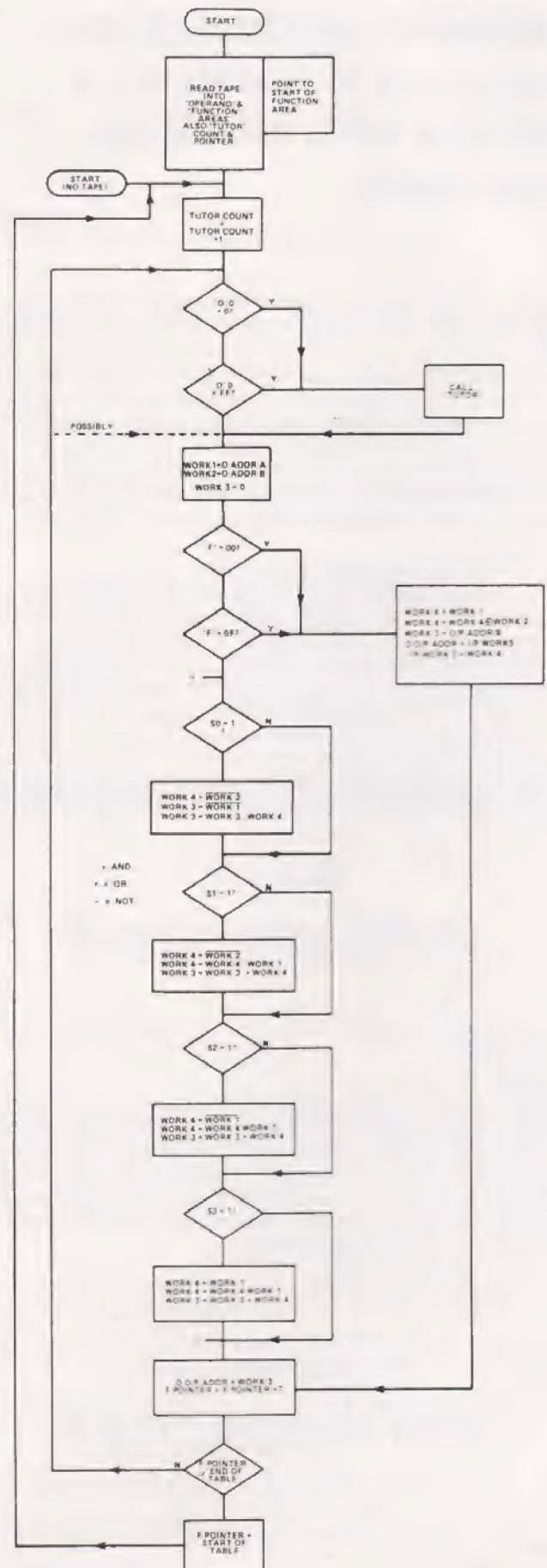


Fig.1. Phase I's processor flowchart.

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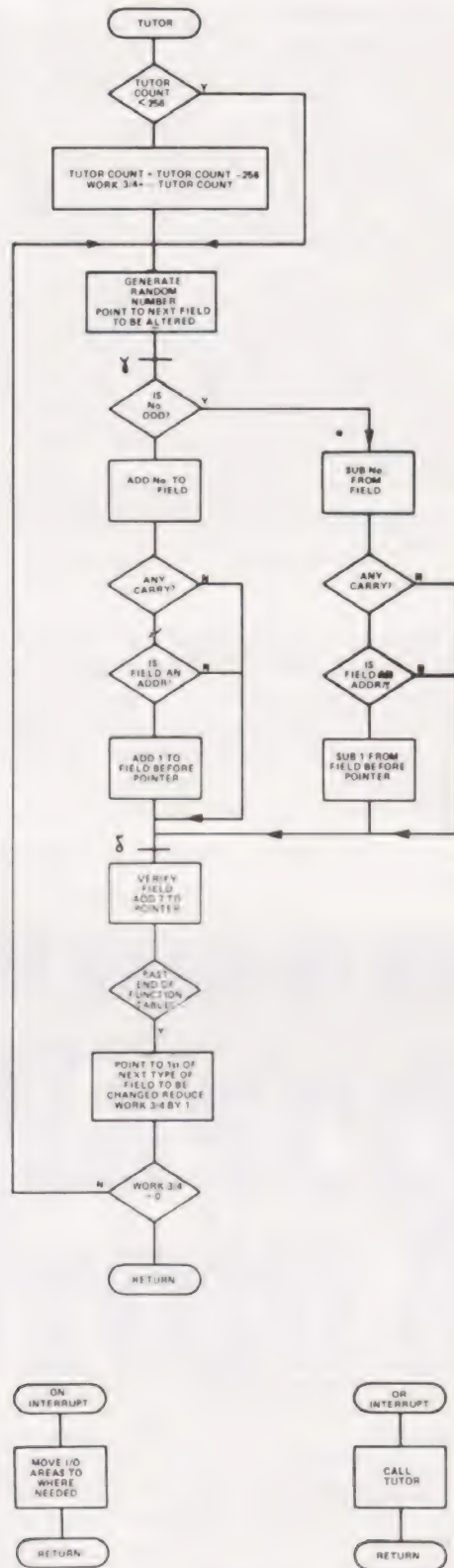


Fig.2. Phase I's Tutor flowchart with its subroutines.

c. Function area. This is a structured area that defines which logical function is to be performed by each cell, where the input variables are and where the output is to be written to the 'operand' area. The structure used is:—

- 1 byte — logic function. The first four bits are zero, the remaining four are the function selector bits S_0 to S_3
- 2 bytes — A input 'operand' 1 relative address.
- 2 bytes — B input 'operand' relative address.
- 2 bytes — output 'operand' relative address.
- (7 bytes total per cell)

The total work area required is $7 + 1 + 1/8 + 1/8 = 8\frac{1}{4}$ bytes per cell in multiples of 8 cells.

2. TUTOR. This program changes the contents of the 'function' area of store so as to produce the required output. There are two ways of achieving this:

a. by setting the 'output' to what is required and then working through the logic chain in reverse changing the functions to obtain the required result. This would work but would become an extremely long process for a reasonable number of cells for the following reasons:

I. After correcting any one byte in the 'output' area the whole function table would have to be reprocessed a number of times. This is because any of the changes made to correct this one byte could have effects elsewhere in the network.

II. The byte altered might be affected by a loop in the network and so not have a constant value.

III. By changing a number of functions in a random manner. The number changed should decrease with time so as not to affect the previous training in too large an extent.

In both cases it would be necessary to repeat previous after any new training, but I believe that the herutistic method will give acceptable results quicker and more easily.

Using the random method of training the following rules apply:

- a. The program will be entered:
 - I. If arbitrarily chosen 'operand' bytes conform to an equally arbitrary pattern, specifically if the first byte of the 'operand' table is \$00 or \$FF. (It wants to learn).
 - II. From an external interrupt when the operator wants to change the output. (I'll larn ya!).
- b. A two byte unsigned count of the number of times the function table has been processed is kept. This count, together with a pointer indicating where the 'tutor' has amended to, needs to be initialised on runs other than the first. The count is decremented by 256 (high order byte by one) whenever the 'tutor' is called. If the count ever becomes \$FFFF then it becomes a constant.
- c. The two's complement of the count, treated as an unsigned number is the number of functions to be altered when the 'tutor' is called.
- d. The 'function' field altered on each pass through the complete table is alternately the logic field or an address field.
- e. The field in question is altered by generating an eight bit random number and adding it to the field if it is even or subtracting if it is odd. The field is then checked for validity.

3. I/O. This program is the interface between the 'processor' I/O areas and the peripherals. For this minimum system the 'processor' I/O area could be situated in the store of a mapped VDU and the system trained to recognise patterns in this area. In this case all that would be needed is for the program to recognise keyboard input destined for this area.

Otherwise the program is driven by a timer interrupt to give a suitable sampling period for the external system and

transfers data between the two systems.

4. An end-of-run program is required to dump the 'operand' and 'function' areas to tape to save them for the next run. This program could also be run periodically during the main run in case of power failures (rather frequent in my area).

Table 3

Multiple function structure:—

2 bytes — record length — only required for variable records.

2 bytes — cell logic selector bits — max Hex '0003' 1 I/P cell
 " " '000F' 2 " "
 " " '00FF' 3 " "
 " " 'FFFF' 4 " "

2 bytes — O/P operand address

2 bytes — I/P 'A' address
 For a variable length record the remaining fields may not be present.

2 bytes — I/P 'B' address

2 bytes — I/P 'C' address

2 bytes — I/P 'D' address

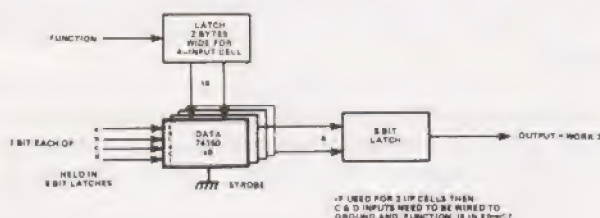


Fig.3. Phase II, delete from α to β in the Processor flowchart and insert: Move function to latch.

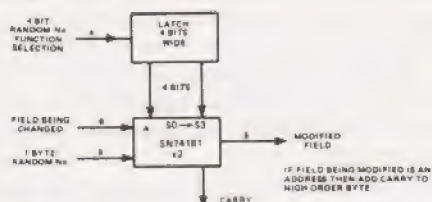


Fig.4. Phase II, delete from γ to δ in the Tutor flowchart.

Phase Two

This differs from phase 1 in the following respects:

a. Increased store for the 'operand' and 'function' tables. This would give the ability to recognise larger patterns. By using the one 'function' table to process two sets of 'operand' and 'I/O areas it is possible to increase the pattern size with little increase in store, but there would be interference between the training for the two areas.

b. The opportunity arises, with increasing store, to increase the complexity of the network by allowing functions with other than two inputs. See the structure/file layout in Table 3; the reason for variable

record is explained later.

c. Using hard wired logic for the "tutors" amendment routines resulting in a greater variety of operations and higher speed. The hardware used will be a pair of SN74181's operated in arithmetic mode. These perform one of sixteen arithmetic or logic operations on two 'operands'. If the field being amended is an address then the low order byte is amended using the 74181's and any carry from them is added to the high order byte.

d. Hard wired logic for the 'processors' logic processing. If the two-input cell limitation is satisfactory then the 74181's above could be used for this. In this case the I/O cell functions are \$03 and \$0F. If cells with up to four-inputs are required then SN-74150's or their CMOS equivalent can be used, but more wiring up is required.

e. At this point it would be more satisfying to have a remote mobile terminal (robot) controlled by the I/O program.

Table 4

External output function:—

Cell type '0000'
 '0003'

The value at the 'A' address is 'exclusive — OR'ed into the output area.

Cell type '000F'
 '00FF'
 'FFFF'.

The 'exclusive — OR' of the inputs is 'EX-OR'ed into the output area.

Reference

Logical Design of Digital Computers.
 Montgomery Philster, Jr.
 Chapter 4 page 94, et seq.

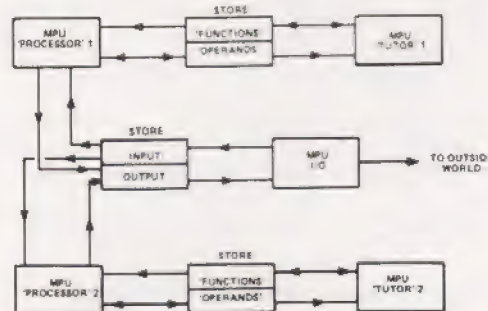


Fig.5. The outline of Phase III's CPU requirements.

Phase Three! (When I'm rich and retired).

In this phase the programs move into a multiple MPU environment with an MPU dedicated to each program. This

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results in the following changes:—

1. The 'processor' only processes the logic cells.
2. The 'tutor' continuously checks the 'self tuition' bytes.
3. The 'I/O' program is also run continuously.
4. A second pair of 'processor' and 'tutor' programs are used. This 'processor' has a very large 'function' store on RAM, disk or tape, in order of preference, with the cells having four or more inputs. If sequential files on tape or disk are used then two files will be needed with the 'tutor' creating a new file each time it is entered and informing the 'processor' when it needs to change files. With this multiple file approach it is also possible to use variable record lengths to offset the longer I/O time of these devices. The 'processor's' I/O area is common to both with the result from this new 'processor' being combined into the output area (see Table 4).

There is no reason why, if response time is not critical, this approach cannot be used with a single MPU.

In Conclusion

Whilst this simulation might be objected to because training takes place in a random manner it must be remembered that any organic intelligence in existence today has had an initial program loaded into it. This program is inherent in its genes and has evolved on a randomly altered basis over millions of years. I would imagine that it will be easier for us to train this simulation that it has been for Nature where both a

general program and the necessary hardware have had to be created.

Training will in all probability be easier starting from a small system that grows than going in at the deep end with the biggest system that can be fitted in your machine.

Concerning the combining of training data, acquired either from another machine or by training for simple jobs, I would suggest the following procedure:—

- a. Enlarge the function area so as to contain both sets of functions.
- b. If one set is from another system amend the function addresses to suit the new area.
- c. Treat both sets as if they are parts of a new contiguous tape file.

A Cautionary Note

The good Dr. Asimov notwithstanding, there is no reason for an intelligent computer to be either tractable or benevolent. I have two organic computers of reasonably high intelligence, one of whom I have been trying to train for six years. This one, (the other is similar in outlook) can on occasion be completely intractable and decidedly malevolent. In fact there are times when I could quite cheerfully murder my son!

In all seriousness I will be pleased to hear from anyone who does try to train the above system. Also, as I have given very little thought as yet to the interface systems, I would welcome any suggestions for these.

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ELECTRONICS I This package will not only calculate the component values for you, but will also draw a schematic diagram, too. You'll need a TRS-80 Level I 4K, Level II 16K to use:

Tuned Circuits and Coil Winding — Design tuned circuits without resorting to cumbersome tables and calculations.

555 Timer Circuits — Quickly design astable or monostable timing circuits using this popular IC.

LM 381 Preamp Design — Design IC pre-

amps with this low-noise integrated circuit. This package will reduce your designing time and let you build those circuits fast. Order No. 0008R 5.75.

HAM PACKAGE I This versatile package lets you solve many of the commonly encountered problems in electronics design. With your Level I 4K or Level II 16K TRS-80, you have a choice of:

Basic Electronics with Voltage Divider — Solve problems involving Ohm's Law, voltage dividers, and RC time constants.

Dipole and Yagi Antennas — Design antennas easily, without tedious calculations. This is the perfect package for any ham or technician. Order No. 0007R 5.75.

Level 2

TRS-80 UTILITY I Ever wonder how some programmers give their programs that professional look? Instant Software has the answer with the TRS-80 Utility I package. Included are:

RENUM — Now you can easily renumber any Level II program to make room for modification, or to clean up the listing.

DUPLIK — This program will let you duplicate any BASIC, assembler, or machine-language program, verify the data, merge two or more programs into one data block, and even copy Level I programs on a Level II machine. For TRS-80 Level II 16K. Order No. 0081R 5.75.

TRS-80 UTILITY 2 Let Instant Software change the drudgery of editing your programs

into a quick, easy job. Included in this package are:

CFETCH — Search through any Level II program tape and get the file names for all the programs. You can also merge BASIC programs, with consecutive line numbers, into one program.

CWRITE — Combine subroutines, that work in different memory locations into one program. This works with BASIC or machine-language programs and gives you a general checksum.

This package is just the thing for your TRS-80 Level II 16K. Order No. 0076R 5.75.

SPACE TREK IV Trade or wage war on a planetary scale. This package includes:

Stellar Wars — Engage and destroy Tie fighters in your attack on the Death Star. For one player.

Population Simulation — A two-player game where you control the economy of two neighbouring planets.

You decide, guns or butter, with your TRS-80 Level II 16K. Order No. 0034R 5.75.

RAMROM PATROL/TIE FIGHTER/KLINGON CAPTURE Buck Rogers never had it so good. Engage in extraterrestrial warfare with:

Ramrom Patrol — Destroy the Ramron ships before they capture you.

Tie Fighter — Destroy the enemy Tie fighters and become a hero of the rebellion.

Klingon Capture — You must capture the Klingon ship intact. It's you and your TRS-80 Level II 16K battling across the galaxy. Order No. 0028R 5.75.

CARDS This one-player package will let you play cards with your TRS-80 — talk about a poker face!

Draw and Stud Poker — These two programs will keep your game sharp.

No-Trump Bridge — Play this popular game with your computer and develop your strategy.

This package's name says it all. Requires a TRS-80 Level II 16K. Order No. 0063R 5.75.

HOUSEHOLD ACCOUNTANT Let your TRS-80 help you out with many of your daily household calculations. Save time and money with these fine programs:

Budget and Expense Analysis — You can change budgeting into a more pleasant job with this program. With nine sections for income and expenses and the option for one- and three-month review or year totals, you can see where your money is going.

Life Insurance Cost Comparison — Compare the cost of various life insurance policies. Find out the difference in price between term and whole life. This program can store and display up to six different results.

Datebook — Record all those important dates in your life for fast, easy access. The program has all major holidays already included.

All you need is TRS-80 Level II 16K. Order No. 0069R 5.75.

FINANCIAL ASSISTANT Compute the figures for a wide variety of business needs. Included are:

Depreciation — This program lets you figure depreciation on equipment in five different ways.

Loan Amortization Schedule — Merely enter a few essential factors, and your TRS-80 will display a complete breakdown of all costs and schedules of payment for any loan.

Financier — This program performs thirteen common financial calculations. Easily handles calculations on investments, depreciation, and loans.

1% Forecasting — Use this simple program

to forecast sales, expenses, or any other historical data series.

All you need is a TRS-80 Level II 16K. Order No. 0072R 5.75.

PET

CASINO I These two programs are so good, you can use them to check out and debug your own gambling system!

Roulette — Pick your number and place your bet with the computer version of this casino game. For one player.

Blackjack — Try out this version of the popular card game before you go out and risk your money on your own "surefire" system. For one player.

This package requires a PET with 8K. Order No. 0014P 5.75.

CASINO II This craps program is so good, it's the next best thing to being in Las Vegas or Atlantic City. It will not only play the game with you, but also will teach you how to play the odds and make the best bets. A one player game, it requires a PET 8K. Order No. 0015P 5.75.

CHECKERS/BACCARAT Play two old favorites with your PET.

Checkers — Let your PET be your ever-ready opponent in this computer-based checkers program.

Baccarat — You have both Casino- and Blackjack-style games in this realistic program.

Your PET with 8K will offer challenging play anytime you want. Order No. 0022P 5.75.

MIMIC Test your memory and reflexes with the five different versions of this game. You must match the sequence and location of signals displayed by your PET. This one-player program includes optional sound effects with the PET 8K. Order No. 0039P 5.75.

TREK-X Command the Enterprise as you scour the quadrant for enemy warships. This package not only has superb graphics, but also includes programming for optional sound effects. A one-player game for the PET 8K. Order No. 0032P 5.75.

TURF AND TARGET Whether on the field or in the air, you'll have fun with Turf and Target package. Included are:

Quarterback — You're the quarterback as you try to get the pigskin over the goal line. You can pass, punt, hand off, and see the results of your play using the PET's superb graphics.

Soccer II — Play the fast-action game of soccer with four playing options. The computer can play itself, play a single player, two players with computer assistance, and two players without help.

Shoot — You're the hunter as you try to shoot the bird out of the air. The PET will keep score.

Target — Use the numeric keypad to shoot your puck into the horn position as fast as you can.

To run and score all you'll need is a PET with 8K. Order No. 0097P 5.75.

ARCADE I This package combines an exciting outdoors sport with one of America's most popular indoor sports:

Kite Fight — It's a national sport in India. After you and a friend have spent several hours manoeuvring your kites across the screen of your PET, you'll know why!

Pinball — By far the finest use of the PET's exceptional graphics capabilities we've

ever seen, and a heck of a lot of fun to play to boot.

Requires an 8K PET. Order No. 0074P 5.75.

ARCADE II One challenging memory game and two fast-paced action games make this one package the whole family will enjoy for some time to come. Package includes:

UFO — Catch the elusive UFO before it hits the ground!

Hit — Better than a skeet shoot. The target remains stationary, but you're moving all over the place.

Blockade — A two-player game that combines strategy and fast reflexes.

Requires 8K PET. Order No. 0045P 5.75.

DUNGEON OF DEATH Battle evil demons, cast magic spells, and accumulate great wealth as you search for the Holy Grail. You'll have to descend into the Dungeon of Death and grope through the suffocating darkness. If you survive, glory and treasure are yours. For the PET 8K. Order No. 0064P 5.75.

Apple

MATH TUTOR I Parents, teachers, students, now you can turn your Apple computer into a mathematics tutor. Your children or students can begin to enjoy their math lessons with these programs:

Hanging — Perfect your skill with decimal numbers while you try to cheat the hangman.

Spellbinder — Cast spells against a competing magician as you practice working with fractions.

Whole Space — While you exercise your skill at using whole numbers your ship attacks the enemy planet and destroys alien spacecraft.

All programs have varying levels of difficulty. All you need is Applesoft II with your Apple II 24K. Order No. 0073A 5.75.

MATH TUTOR II Your Apple computer can go beyond game playing and become a mathematics tutor for your children. Using the technique of immediate positive reinforcement, you can make math fun with:

Car Jump — Reinforce the concept of calculating area while having fun making your car jump over the ramps.

Robot Duel — Practice figuring volumes of various containers while your robot fights against the computer's mechanical man.

Sub Attack — Take the mystery out of working with percentages as your submarine sneaks into the harbor and destroys the enemy fleet.

All you need is Applesoft II with your Apple II and 20K. Order No. 0098A 5.75.

GOLF Without leaving the comfort of your chair, you can enjoy a computerized 18 holes of golf with a complete choice of clubs and shooting angles. You need never cancel this game because of rain. One or two players can enjoy this game on the Apple with Applesoft II and 20K. Order No. 0018A 5.75.

BOWLING/TRILOGY Enjoy two of America's favorite games transformed into programs for your Apple:

Bowling — Up to four players can bowl while the Apple sets up the pins and keeps score. Requires Applesoft II.

Trilogy — This program can be anything from a simple game of tic-tac-toe to an exercise in deductive logic. For one player.

This fun-filled package requires an Apple with 20K. Order No. 0040A 5.75.

We take a close look at this development system and its capability for expansion into bubble memories

Rockwells Advanced Interactive Microcomputer has been around for quite some time but seems to have received little attention perhaps because it won't interface to a VDU and therefore can't be used for playing real time, interactive games. It seems there are other uses for micro's!!! With no video interface the AIM relies on the on-board 20 column thermal printer and 20 character, 16 segment LED display.

Description

The standard machine consists of two boards, one holding the keyboard the other the processor, LED display, and printer. The boards are coupled by ribbon cable terminated by DIL plugs. The CPU is the 6502 as found in KIM, SYM, PET and Superboard to name but a few. 1K User RAM is provided in two 2114's, six extra sockets provide for on-board expansion. A very comprehensive monitor in ROM is standard with a further three sockets for the assembler (1 ROM) and BASIC (2 ROM's). If desired any pin compatible ROMs, EPROMs or PROMs may be used and their contents called using the appropriate Monitor function.

I/O is available via two edge connections labelled "Application" and "Expansion". The Application port provides two 8 bit I/O ports from the Versatile Interface Adapter — a chip allowing a fantastic range of possibilities. Cassette and TTY interfacing are also via the application port. The addressing capability of the 6502 is limited to 64K and this limits the amount that can be hung on to the expansion port. For the real trailblazers Rockwell have Bubble Memories (and Space Shuttles) to append to the 6502. More on Bubble memories later. A power supply is required giving 5 V @ 2 amps for the CMOS. The current drawn depends on the amount of memory and which chips are used. The printer requires 24V. A simple PSU will be described next issue.

Documentation

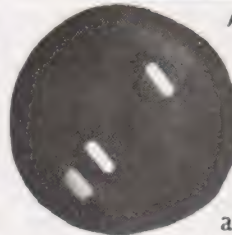
Four books are supplied with the AIM, the users guide which gives an introduction to programming and interfacing the machine, hardware and programming manuals which go into much more detail, and a complete disassembled listing for the monitor. All are in A5 paperback format and are very complete technical manuals as you would expect from a machine designed as a complete development system. All assume a fair knowledge of microprogramming except the users guide which gives programming examples, and demonstrates each of the monitor functions in use. It also includes a detailed memory map and the locations and functions of the monitor subroutines.

The Monitor

The AIM comes complete with a ROM based monitor/disassembler/text editor which allows machine code or mnemonic programming from the 54 key keyboard. Fig.3 gives the monitor functions and some idea of what they do. Part of the monitor is given over to a text editor, more about this later. Illegal commands are followed by question marks on



Above: the AIM package plus CT PSU (right). Full details of this next month.



the display whether it is the monitor or text editor that is in control.

The processor used is the ubiquitous 6502 and in this machine it is extremely accessible. All the registers can be accessed, displayed and amended at any stage of programming. Using the single step program execution facility the registers can be inspected at each step. Four breakpoints can be set using command "B", toggled using command "A" and their position displayed by "?".

Incorporated in the Monitor are several subroutines available to the user through the JSR instruction. At the end of the subroutine control is returned to the instruction after the JSR.

Practical Programming

On powering up the AIM performs its own cold start, puts a header "ROCKWELL AIM 65" on the printer and the monitor prompt (<) on LED display. If for any reason the printer is out of commission the message "PRINTER DOWN" appears.

Assuming that there is a monitor prompt on the display the machine is awaiting a command. Any letter or symbol input from the keyboard is enclosed between < > signs. If the command is illegal the display is terminated with a question mark and the machine awaits a further instruction.

To enter a program the stack pointer has to be reset to the starting address required using "*". To enter a program in Hex "/" is used. The start location appears on the

AIM 65



display and four bytes of program may be entered. If the printer is on, the start location and the four bytes are printed. The LED display shows the monitor prompt again and by using "/" again the next four bytes can be entered in the same way.

When the program is entered it can be inspected using the "M" command after resetting the stack pointer to the start address using "*". When the "M" command has been initiated pressing the space bar increments the stack pointer by four causing the next four locations to be displayed/printed.

Programming mnemonics is a little different. The Mnemonic mode is called using "I". This results in the current value of the stack pointer being displayed with a cursor. The machine is now awaiting a three letter mnemonic instruction. If it doesn't get one the word "error" is flashed on the display/printed. The Program counter is not incremented in this case and you get another try at it.

Programs can be disassembled to mnemonics using the "K" command. The output format is :- four characters of location, two characters of opcode, three letters of mnemonics, and an operand if applicable. This procedure applies to programs entered in both mnemonics and Hex.

To run a program the stack pointer has to be set to the start address using "*" and the "G" command starts the program execution. A miniature slider switch to the left of the display can be used to select either single step or continuous execution. If switched to single step the contents of the registers can be examined after each step for debugging purposes.

Text Editor

I was surprised to find a Text Editor as part of the standard system software. I was even more surprised to find it was so comprehensive. The user manual implies that the Editor's main function is to manipulate programs written under the optional assembler but I can visualise various 'filing cabinet' applications.

The system is basically line orientated i.e. operations are carried out on one line at a time and a pointer (which is not displayed) can be manipulated to indicate any particular line. In this context the word line is misleading as it can be up to 60 characters long and therefore represents three lines on the AIM's printer and display.

The Editor is initialised from the monitor by typing "E". The machine responds by asking which block of memory is to be used for the text buffer. Any contiguous block from Hex location 0200 upwards can be used and if space or return is entered the maximum space is allocated. On the standard machine, which has 1K RAM, the Text buffer can extend to 0400 Hex giving memory space for 512 characters including carriage returns (which must terminate each line) and an end of text character.

Text can be input from and output to the buffer from the keyboard, audio tape, paper tape or TTY. It is stored as ASCII code. Unfortunately lower case cannot be input from the keyboard or displayed by the LED's or printer although the ASCII codes can be stored (I tried it using the "M" command and entering Hex ASCII code) so the lucky user who owns a full ASCII keyboard and a fair printer has the beginnings of a usable RAM based word processor system. Naturally 1K RAM is insufficient for any serious purposes but consider what I have to say about bubble memories later.

The commands available under the Text Editor are listed in Fig.2, the string orientated functions "C" and "F" being particularly useful but when using them it must be

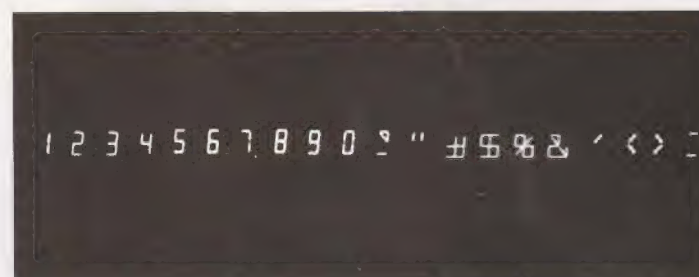
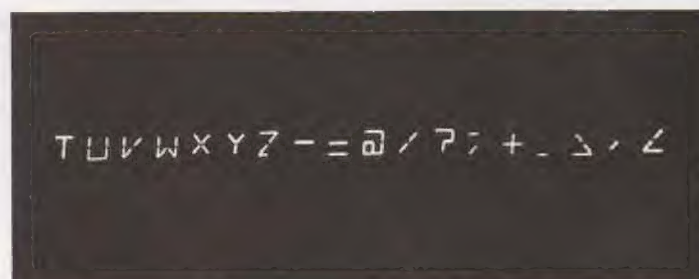


Fig.1. The AIM 65 character set as displayed by the 16 segment displays.

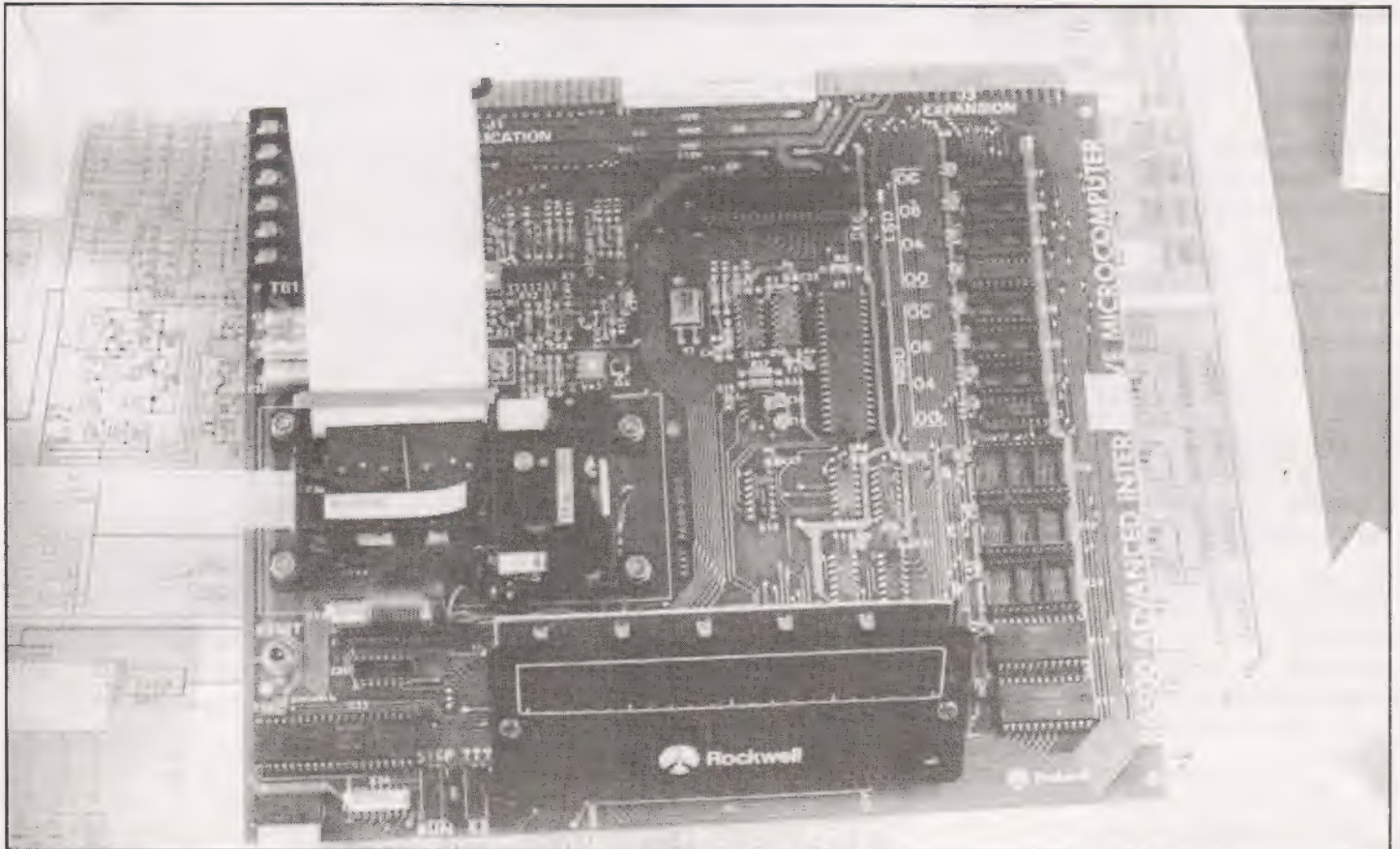
borne in mind that the search is only carried out from the current line downwards so for a full search the "T" command must be used to set the text pointer at the top.

Output Instructions

The application connector on the AIM allows two tape recorders to be used. Provision for remote control of tape motors is included but is only absolutely necessary for use with the optional assembler. Any recorder can be used as long as it has earphone and microphone sockets. The user guide goes into a great deal of detail and includes a program that produces a test tape of characters which can be played back to the machine where another program will check them for legibility and display a "Y" if the tape is being successfully read. If it isn't "N" is displayed. As with most other aspects the manuals are excellent. A complete troubleshooting guide is given with details of how to make adjustments in case the setting made at the factory is upset at all.

Because of the excellent monitor dumping data to tape is simple. In the monitor the command is "D" and when entered a start and finish address are requested. If you reply with something blatantly daft the prompt remains until a sensible reply is given. The output device is now requested if the reply is not P, X, T, K, L, or U, the output defaults to the AIM's own printer. Fig.3 sheds light on the output device codes. This can be a little unfortunate if you're dumping 64K as this represents a lot of paper through the printer. During a dump the only escape is the reset button!

A five character file header can be used for both the hex dump and the ASCII listing. Spaces are not permitted in the filename and hitting the space bar terminates the heading and causes the next prompt, which asks to which tape (one



Above: the main PCB in somewhat more detail. The display sits neatly on the front of board.

or two) the data is to be written.

Two tape formats are available, either AIM's own or KIM-1 compatible. The AIM format records the data in blocks of 80 bytes, the first block includes the file name. All blocks are preceded by 32 SYN characters, and a block number. Whilst a Hex dump is taking place the block number is shown on the two rightmost digits of the display. Although this is of little practical use it gives you something to look at other than the tape going from one spool to the other! Each block is followed by two bytes of checksum. If the data does not fill the last block zeroes are used to make it up to the 80 characters.

Outputting data in the KIM-1 format requires the same procedure by the operator and the only immediately apparent difference is that no block counter is displayed (KIM format consists of a continuous string of data).

When the finish address is reached (whichever output format is used) the display shows "More?". Anything other than Monitor "Y" in response is treated as no and the machine awaits a further command.

The contents of the Text buffer can be listed to tape using the "L" command. As with the rest of the Editor commands the required action is only taken from the current line so the "T" command has to be used if the listing is required from the first line of text. When the "L" command is entered a "/" appears on the display requesting a decimal number indicating the amount of text (in lines) to be output. Replying with a space causes the whole of the text in the buffer to be transmitted. The choice of output device, and, if tape, filename and choice of machine are as for the dump command in the monitor.

The TTY output can be selected using a switch on

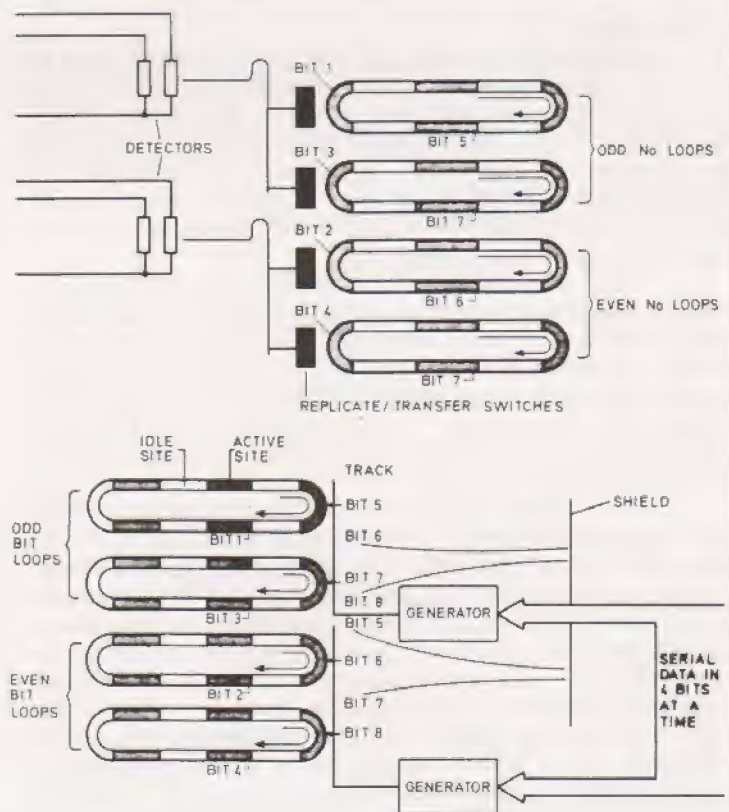


Fig.2. A 16 bit bubble memory using four 'loops' of generation.

the main board. With this switch in the TTY position output to the AIM's printer is diverted to the 20 mA current loop port on the Application connector. The baud rate of the AIM automatically sets in response to typing the RUBOUT key on the TTY. Once set control can be transferred from keyboard to TTY and vice versa by using the KB/TTY switch. Output to a paper tape punch on the TTY is achieved using the output device code L.

Input Instructions

The monitor command "L" allows object code to be loaded into memory from audio tape, TTY punched tape or a user defined input device, the device codes are as for the output instructions. The object code is loaded starting from the memory location indicated by the program counter. (If the file name specified isn't the first on a cassette the titles of the files encountered are displayed).

Text can be loaded into the Editor, using the "R" command in a similar fashion from any of the above mentioned sources.

User Programmable I/O

The Versatile Interface Adapter on the AIM is an R6522 and is exactly what it says — versatile. There are two incorporated into the design; one looks after the I/O mentioned above and the tape remote control and the other is available to the user to do with what he/she will. The facilities available are :—

- Two 8 bit parallel I/O ports
- Two interval timers
- Two serial I/O ports

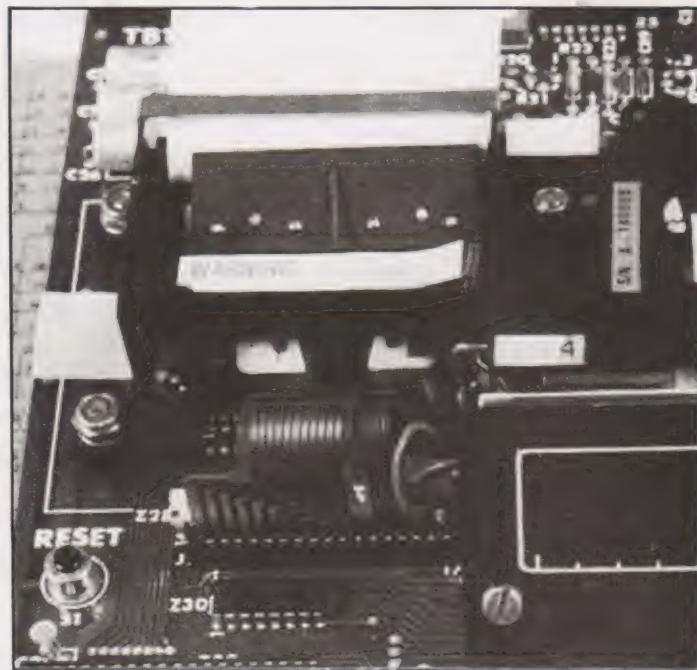
Control of the chip is achieved by addressing memory from A000 to A00F. Rockwell's suggestions for applications range from monitoring equipment to testing integrated circuits.

AIMing High

The expansion port can be used to increase the total RAM to 64K or, using Rockwell's Bubble memory controller up to 2M bytes of non-volatile store. It seems only a few months ago I read in the scientific press that researchers had found that certain materials could be induced to form pockets of magnetism which, by using coils could be made to rotate along defined tracks. The RBM256 device uses these bubbles to store 256K bits on a single chip!

The 1025 bubble positions are rotated in each of 282 loops, only 260 of which are actually used. This redundancy allows for faulty loops which are identified at the factory when the device is tested and hence reading from them is avoided. Bubbles are generated and fed into the loop at the input port, the presence of a bubble representing a one and the absence a zero. Active data sites are alternated with idle sites in the loops.

The "write" procedure is performed by two generators (bubble-blowers?) one serving a set of loops storing the odd bits and the other the even bits. They are synchronised so that the first odd bit and that first even bit, arrive simultaneously at their appropriate loops. Fig.2 shows a 16 bit memory with four loops and four active storage sites on each. When the bubbles are aligned apposite their respective loops transfer switches allocate them to an active data site, reading the loops also has to follow the same pattern but the read cycle is further complicated by the fact a bubble has to be removed from its loop to arrive at one of the pair of detectors. Naturally if bubbles were removed from the loop the store would be lost. To overcome this replicate/transfer switches are used. These either copy or transfer bubbles depending on whether a destructive read is required or not.



Above: AIM is printer with appropriate warning on use of 'pirate' paper!

The detectors work because a distorted bubble alters the resistance of a stack of permalloy chevrons. To eliminate the problem of stray fields causing noise the signal from a dummy stack that has not encountered a bubble is subtracted from the "real" stack.. Any remaining signal must be due to the presence of a bubble.

A 15kHz or 100kHz signal can be used to drive the field which rotates the loops one bit being output for each cycle. The bubbles are unable to exist outside a magnetic field so to ensure non-volatility permanent magnets are used to maintain the condition of the loops after power down.

Of course all this shifting around of bubbles requires control and co-ordination and this is the function of the RCM650 Bubble memory control module. Centred around another 6502 with its own RAM, PROM's and interface chips it is designed to be compatible with the System 65 bus. One RCM650 will run up to sixteen 1/8M byte RLM658 modules, each of which has 4 256 Kbit memory cells.

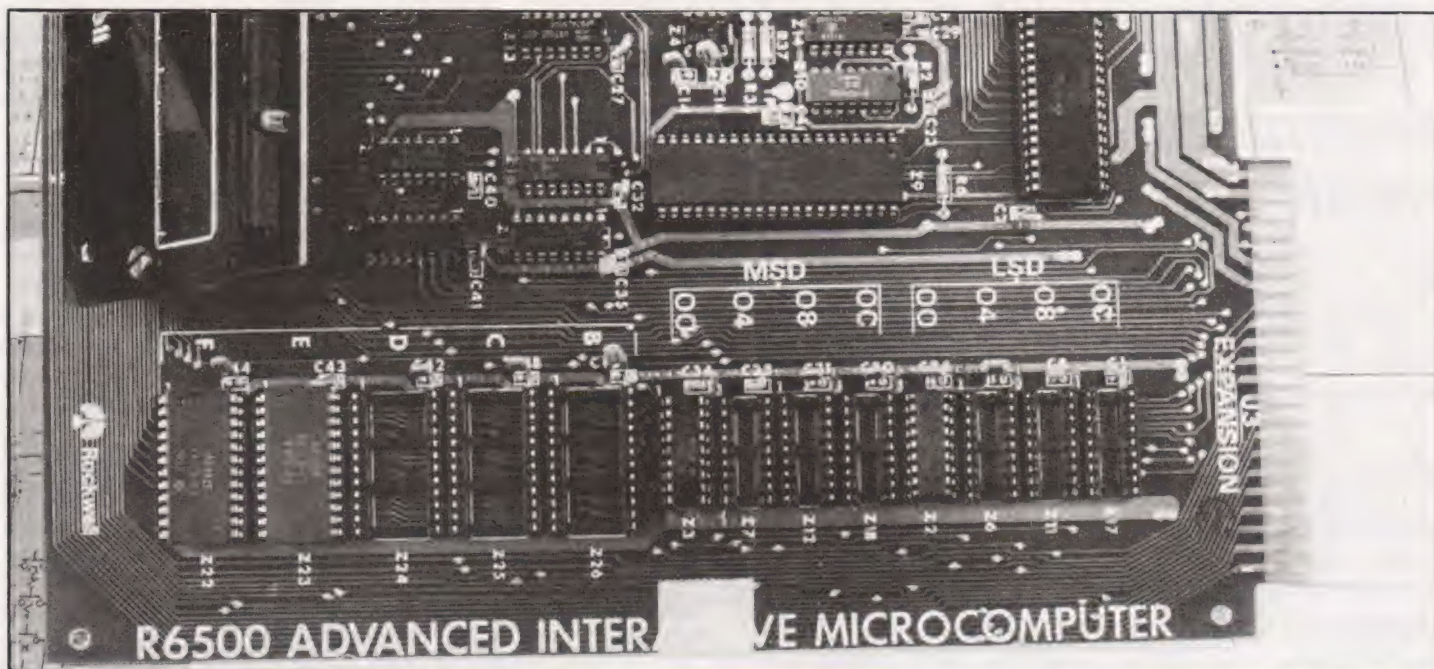
Now I've stimulated your interest I'm going to spoil it by mentioning the drawback—expense. The controller Module will set you back £700 and each 1/8M byte bubble memory module is £1750. I didn't dare ask how much the space shuttle was

Seriously though, although £4200 for 1/4M byte at first sight seems a lot we are dealing with the 'frontiers of the technology' and congratulations to Rockwell for making it available at *any* price.

Down To Earth Again

The basic AIM65 only sets you back around £250 and is as good a starting point as any as I've come across. The documentation is excellent. A lot of manuals I've seen hint at the incredible power under your finger tips but getting at it is left to trial and error — great if you like guessing games. Personally I prefer details and there was no lack of these. Well done Rockwell!!!

The AIM is distributed in the UK by Pelco (Electronics) Ltd, Enterprise House, 83-85 Western Road, Hove, Sussex and we would like to thank them for the loan of the machine.



Above: expand your AIM to take in bubble blowers and other BASIC necessities.

Command	function/comments	#	
		?	Clears all breakpoints.
A	Alter accumulator	4	Displays addresses of breakpoints.
B	Set or clear a breakpoint	5	Toggles breakpoint enable.
	Breakpoints are numbered 0-3 and are handled individually under this command.	6	Enters and initialises BASIC if you have it.
D	Dumps a specified section of memory.	/	Re-enters (warm starts BASIC).
	Prompts for starting and ending addresses and output device. Defaults to on board printer.		Program in Hex.
E	Enters and initiates Text Editor.		
	This allocates memory for text clearing it. Only to be used for cold starting editor.		
G	Executes program from instruction currently indicated by Program counter. Single step execution can be selected or a given no. of instructions may be specified.		
H	Traces program counter history.		
I	Calls up mnemonic instruction mode.		
K	Disassembles memory. Starting address and number of instructions to be specified.		
L	Load from input device.		
M	Displays memory from a specified byte. Four bytes are on LED display at once. Pressing space bar steps to next four bytes.		
N	Enters Assembler if you have it. If you don't and have nothing in the ROM space starting D000 the machine hangs up until reset is pressed.		
P	Alter processor status.		
R	Displays register values. Can be selected during single step execution so that registers are displayed after each step.		
S	Alter stack pointer.		
T	RE-enters text editor at top of text. Can only be used after Text editor has been set up using E.		
V	Toggles register trace mode.		
X	Alters X register.		
Y	Alters Y register.		
Z	Toggles Instruction trace mode.		

Fig.3. How to tell it what to go and do once you've got it. Commands list.

Text Edit commands

B	Moves the text pointer to the bottom line of text.
C	Searches for line containing a specified character string and allows it to be changed if required.
D	Displays next line of text.
I	Inserts a line.
F	Finds a specified string and displays the line containing it.
K	Deletes lines of text.
L	List text.
Q	Gets you back to monitor.
R	Read from input device. Defaults to keyboard

Input/output device codes

T	Audio tape AIM65 format.
K	Audio tape KIM-1 format.
L	Paper tape punch/reader.
U	User defined device.
P	AIM65 printer.
RETURN Or SPACE	AIM Keyboard/Display and printer or TTY keyboard/printer.

Fig.4. Text editor commands and below that the codes which will tell you which device is doing what and when.

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
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Acorn File Namer

The following program for the Acorn allows you to load and store programs on cassette tape with an eight digit(Hex) file-code. The program uses 128 bytes of RAM and is located to start at 0E80.

The following Monitor subroutines are used:-

FE0C DISPLAY
FE88 QDATFET
FEB1 PUTBYTE
FF6A STORE
FFDD GETBYTE
FF80 LOAD

Instructions For Program Use

Using the Acorn Monitor, GO at 0E80, (Display is - - - - -) Press S for Store or L for Load. When storing the display will now show Fxxxx - - -. Set FAP by entering the start address of the program to be stored, terminating with any command key. The display now shows t xxxx - - -. Set the TAP by entering the terminating address of the program, terminated with any command key, the display will now show 00000000 (all zeroes). Now enter any number of hex digits (the file code) up to a maximum of eight and terminate with any command key. If more than eight digits are entered the program will store (or load) on entry of the ninth digit.

On termination the display will blank and after the program has stored your file code will re-appear. You can now press any command key to re-enter the Monitor.

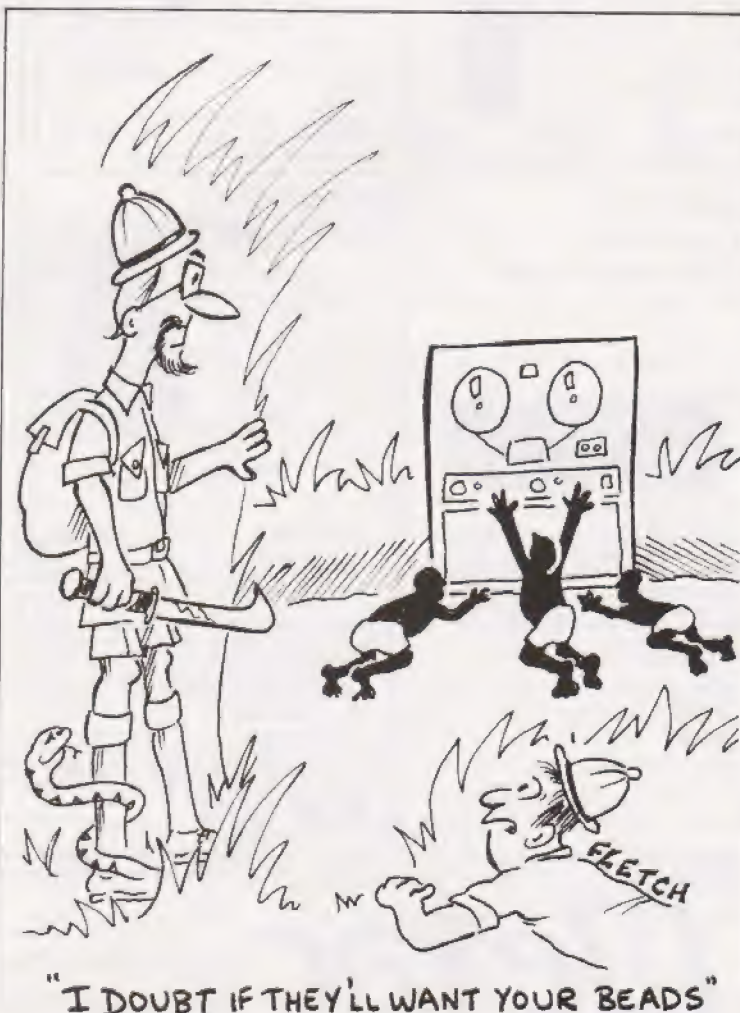
Note:- Set your cassette machine to RECORD before you terminate the file code. The data is recorded in the following format, eight AA's, file code in seven segment code, Start address, End address, Program.

To load a program press L, display shows all zeroes, and then enter the file code of the required program terminated with any command key. The display will now blank.

On recognition of your file code following the eight AA's of the filemarker the data will be loaded. Loading is performed under the Acorn's Monitor and on termination your file code will re-appear. Press any command key to enter the Monitor. As the program looks for a filemark and a file code before attempting to load any data glitches between blocks of data are ignored.

0E80	A9 40	LDA 1	Set up display
0E82	20 F8 0E	JSR Write Display	
0E85	20 0C FE	JSR Display	
0E88	A5 0D	LDA Z	Get Key
0E8A	C9 14	CMP 1	
0E8C	F0 35	BEQ LOAD	
0E8E	C9 13	CMP 1	
0E90	D0 F3	BNE JSR Display	
0E92	A9 71	LDA 1	Store! Set Disp 0=F
0E94	85 10	STA Z	
0E96	A2 06	LDX 1	Set X=FAP
0E98	20 88 FE	JSR QDATFET	Load FAP
0E9B	A9 78	LDA 1	Set Disp 0=t
0E9D	85 10	STA Z	
0E9F	A2 08	LDX 1	Set X=TAP
0EA1	20 88 FE	JSR QDATFET	Load TAP
0EA4	A9 3F	LDA 1	Set up display all 0's
0EA6	20 F8 0E	JSR Write Display	
0EA9	20 E6 0E	JSR Write Filecode	
0EAC	A2 07	LDX 1	Out Filemark
0EAE	A9 AA	LDA 1	'Load Filemark'
0EB0	20 B1 FE	JSR PUTBYTE	
0EB3	CA	DEX	
0EB4	10 F8	BPL Load Filemark	
0EB6	A2 07	LDX 1	Out Filecode

0EB8	B5 10	LDA Z	'Load Filecode'
0EBA	20 B1 FE	JSR PUTBYTE	
0EBD	CA	DEX	
0EBE	10 F8	BPL Load Filecode	
0EC0	4C 6A FF	JMP Store	'Store Program'
0EC3	A9 3F	LDA 1	'Load'
0EC5	20 F8 0E	JSR Write Display	Set up display all 0's
0EC8	20 E6 0E	JSR Write Filename	
0ECB	A2 07	LDX 1	Set up X1 'Check Filemark'
0ECD	20 DD FE	JSR GETBYTE	'Data From Tape'
0ED0	C9 AA	CMP 1	
0ED2	D0 F7	BNE Set Up X	
0ED4	CA	DEX	
0ED5	10 F6	BPL Data From Tape	
0ED7	A2 07	LDX 1	Set up X2 'Check Filecode'
0ED9	20 DD FE	JSR GETBYTE	
0EDC	D5 10	CMP Z	
0EDE	D0 EB	BNE Set Up X1	
0EE0	CA	DEX	
0EE1	10 F6	BPL GETBYTE	
0EE3	4C 80 FF	JMP Load	'Load Program'
0EE6	A2 F7	LDX 1	'Write Filecode'
0EE8	20 0C FE	JSR Display	'Set up display'
0EEB	B0 0A	BCS RET	Command Key = RET
0EED	A4 0D	LDY Z	Hex-7Seg using FONT
0EEF	B9 EA FF	LDA Abs Y	
0EF2	95 19	STA Z	
0EF4	E8	INX	
0EF5	30 F1	BMI JSR Set up display	
0EF7	60	RET	Return
0EF8	A2 07	LDX 1	'Write Display'
0EFA	95 10	STA Z	Store Acc in display
0EFC	CA	DEX	
0EFD	10 FB	BPL Store Acc	
0EFF	60	RET	Return



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month, date, auto
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Very slim only 8mm thick



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and back
Adjustable bracelet
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and date
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M4

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M5

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22 functions
Constant display of
hours and mins. plus
optional seconds
or date display
AM PM indication
Month date
Continuous display
of day
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in 1:10 second steps
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modes
Dual time zones
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M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

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22 functions
Solar panel with
battery back-up
6 basic functions
stop-watch to
12 hours 59.9 secs
in 1:10 sec. steps
Split and lap timing
modes
Dual time zones
Alarm
9mm thick
Back-light
Fully adjustable
bracelet

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M7

ALARM CHRONO with 9 World Time Zones

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- 6 basic functions
- 8 further time zones
- Count-down alarm
- Stop-watch to 12 hours 59.9 secs in 1:10 sec. steps
- Split and lap timing modes
- Alarm
- 9mm thick
- Back light
- Fully adjustable bracelet

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M8

SOLAR QUARTZ LCD Chronograph

Powered from
solar panel with
battery back-up
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date day of week
1:100th 1:10th secs.
10X secs. mins.
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Back light Auto
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and back
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ference

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M15

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In part 5 we looked at the memory transfer system which uses program-counter displacement, and noted that it's limited to steps of +127 or -128 from the program count at the stage when the transfer is programmed. This is the sort of transfer instruction which every microprocessor chip has in its instruction set, but there are always others. In this Part, we'll look at the other choices which the INS8060 can offer. These involve the use of a set of sixteen-bit registers which are called pointer registers. These registers can be loaded from the accumulator (in two steps, because the accumulator holds one byte only), or their contents exchanged might not look too promising at first sight, but the SC/MP can work quite a few neat tricks with these few instructions.

A Quick Mod

Before we start to look at these methods, a small alteration to the Eurobreadboard layout helps to make what is happening much clearer. The modification consists of soldering a 2k7 resistor to one lead of a spare LED, and then connecting this lot between address line A11 (location B5 on the Eurobreadboard) and earth (on Y1). The LED and resistor need not be positioned precisely, just strung between these points, just make sure that the LED is the right way round, and that the bare wires are not shorting against anything else. The idea of this is to find out when the program counter changes to a much higher address number, higher than can be achieved by a program-relative displacement from the first four address lines.

Let's start by looking at how a pointer register can be loaded. The 8060 contains four sixteen-bit registers, coded 00 (which is the program counter), 01 (Pointer 1, P1), 10 (P2) and 11 (P3). We shall work with P1 only, because the methods which we use can be applied to the others simply by changing the last two bits in the code instruction. Each instruction which makes use of pointer registers consists of a 'root' of 5 or 6 bits, and an ending of the two bits, noted above, which specify which pointer register (or program counter). There can be another code bit as well — you'll have to wait a mo'.

Loading Your Pointer

To load a number into the pointer P1, we start by loading the accumulator. After the usual RESET and CANCEL steps, set up 11000100 (LDI), PUSH, 00001000 PUSH. This sets up the number 00001000 in the accumulator. The next step is to exchange the number in the accumulator with the high order byte of P1, using instruction XPAH. This is done by setting the toggles to 00110101. Note the last two bits, 01. If we had wanted to exchange with P2 we would have used 10, and if we had wanted to exchange with P3 we would have used 11. The first six bits of this instruction are common to all the XPAH shifts. When PUSH is operated, the exchange takes place, and the higher order byte of P1 is now equal to the number, 00001000 which was set up in the accumulator. Any number which was in the higher order byte of P1 is now in the accumulator — in our example, this will be zero because we reset all the registers before starting.

We can now load a lower order byte by a similar set of steps, but using the instruction XPAL — exchange the lower order byte of the selected pointer with the number in the accumulator. In this example, we don't really need to load up because we are using a set of zero bits and the reset procedure will have provided these anyway, but we need the experience at this stage. The steps are: 11000100 (LDI) PUSH 00000000 (data) PUSH 00110001 (XPAL) PUSH. Once again, the 01 ending of the XPAL instruction indicates that we're using Pointer 1. The result of all these steps is to load the P1 register with the number 0000100000000000.

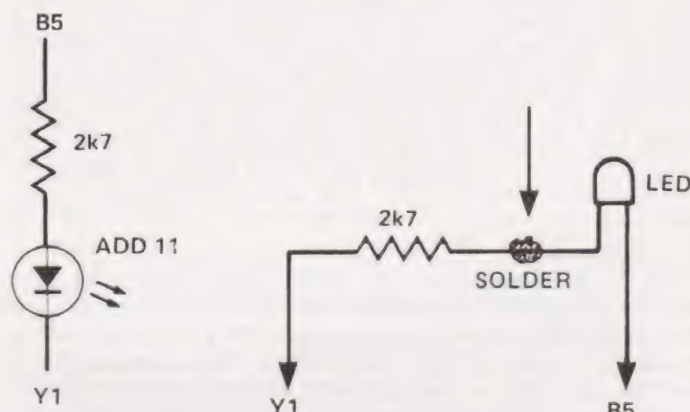


Fig.1. Adding an LED to detect the bit on the A11 address line. (a) Circuit, (b) the practical arrangement.

The "1" bit is at place A11 (starting at A0 remember), and will cause our newly added LED to glow when it appears at this address line. We'll refer to this LED as the A11 LED.

Looking At Effects

Now we can look at the effect of a memory reference instruction which loads a number from memory into the accumulator. The basic load instruction has five bits, 11000. This is made up to the required total of eight by an index code bit, which we'll come to later, and the usual two bits which specify which pointer register we're using, 01 in this example. Note the address at this point, which should be 0111 after the last PUSH. Now set up the LOAD code, 11000001 PUSH, which means Load-relative-to-P1. This gets the address to 1000. The next byte must be a displacement — try 00000001 PUSH. Now look at the address LEDs. The A11 LED is lit, indicating the effect of the pointer register number, and since a displacement of 1 was specified in the byte following the LOAD instruction, the four low order address LEDs are at 0001, not at the 0000 which was placed in the program counter from the pointer.

This style of memory addressing is called indexed addressing, with the number stored in the pointer referred

to as the index number — all displacements are then relative to the index number rather than to the program counter number. As before, both positive and negative displacements in the usual range of +127 to -128 are possible.

A very useful variation on this scheme is called auto-indexing. Let's look at some examples. The basic sequence is to load the upper P1 as before; and if the RESET — CANCEL sequence has just been used, then we don't need to load the lower byte of P1, it will automatically be set at zero. Now use the LOAD instruction coded as 11000101 PUSH 00000001 PUSH, and then follow with 00001000 (NOP) PUSH. We're not interested in the data steps here, but in the address LEDs. On the first LOAD step, the address is 0101, but when the data byte is loaded in, the address changes to 0000, with ADD11 LED glowing to show the bit which was loaded in from pointer P1. Note the difference from the previous load — the instruction has a 1 in the 6th bit, and there has not been any addition of 1 to the basic address which was loaded into the P1 register — which means that the data byte didn't act as a displacement. We're not finished, though. At the end of the NOP step, which has been put in to allow the address to return to normal, the address is 0110, and the ADD11 LED is not lit — we're back on the normal count. Now go through the program steps of loading from the address given by the pointer once again, without resetting. This means 11000101 PUSH 00000001 PUSH. This time the data byte produces the address 0001, with ADD1 LED lit. This is one step on from the previous address which was fetched the last time. Try it all again, remembering to insert the NOP step so as to return to normal addressing first, and you'll find that the P1 address produces 0010 and ADD11 this time. Now we can explain what is meant by auto-indexing. Each fetch from memory (or load to memory) type of instruction, using the P1 indexed relative instruction, has caused the memory address to increment by one at each repeat of the fetch or load. This increment of 1 has been specified by the data byte 00000001 which followed the LOAD instruction — if we'd used 00000010, then the memory would have incremented by two each time. This byte which follows the instruction is not, therefore, a displacement number but an increment number, and the automatic incrementing is ordered by the 1 in the 6th place of the instruction byte (reading from the left this time).

Down Instead Of Up?

Next question obviously, is can we decrement the pointer memory as it happens. We can because the increment byte is interpreted by the microprocessor as a signed binary number, so that if we use 11111111 as the increment number, the address will be decremented by 1 on each instruction.

To work, then RESET, CANCEL, and then load up the P1 register, using the usual routine: 11000100 PUSH 00001000 PUSH 00110101 PUSH, so that the pointer 1 register has a 1 in place ADD11. Follow this now with 11000100 PUSH 00001111 PUSH 00110001 PUSH, which loads the byte 00001111 into the lower byte of P1. The result of this is to load P1 with 0000100000001111, which should cause all of the address LEDs including LED11 to light when this address appears on the address lines.

Now do a NOP to clear the decks (00001000 PUSH), and the displayed address should be 1000. Just for a change, we'll use a STORE instruction rather than a load instruction, the one which is referred to in mnemonic forms as ST@P1, meaning STORE WITH AUTO-INDEX RELATIVE TO P1 (the @ sign is used to indicate auto-indexing). The ST @ P1 is coded as 11001101, with the usual meanings for the last three bits. This causes the address after PUSH to display

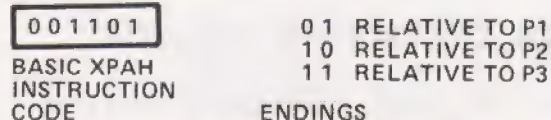


Fig.2. A basic 6-bit instruction code, and the variable 2-bit endings.

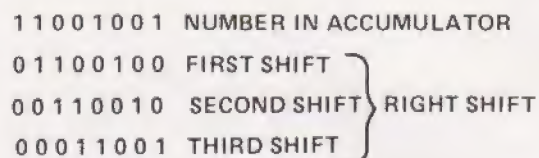


Fig.3. The SHIFT operation.

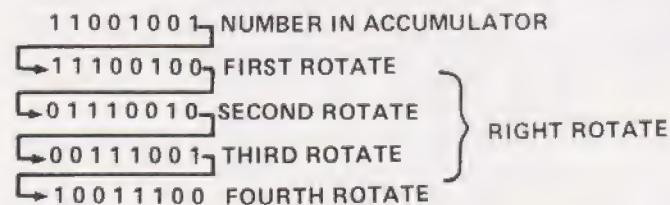


Fig.4. The ROTATE operation.

1001. The next byte is 11111111 (equal to -1 in 2's complement form), and the PUSH after this one causes the transfer, showing memory address 1110 (one less than 1111) and ADD 11 lit. Note that the decrement has taken place on the first transfer, causing the address which was loaded, 1111, to be decremented to 1110. Now do the NOP to return to normal addressing, to step 1010, and go through the whole set of ST @ P1, -1, NOP again. This time the address which is fetched is 1101, ADD 11, which is one less than before. Keep taking the medicine, and watch the address lines!

Why should we want this auto-indexing? In many microprocessor applications we need to keep a large chunk of memory filled with data bytes which also need to be taken out, byte by byte, in order. An obvious application is when we use each byte to represent a letter of a word, so that the bytes must be in the correct order to assemble the word. Another example is when we need to keep a table of number values stored for the purposes of using in order, perhaps for drawing a graph. The use of both increment and decrement on auto-indexing makes it possible both to load such a table and to read out the bytes either in the order in which they were stored or in the opposite order, as we choose.

Pointing To An Address

Back to the board. If you haven't yet reset, you can now check the contents of the lower byte of pointer P1 by using the exchange-with-program counter instruction, XPPC, which is coded 00111101. Check what the last address was in P1 — you will find that the exchange takes place, and then the program counter, which now contains the address which was in P1, increments at the end of the instruction, so that the address which you will see displayed will be one bit more than the number which was stored. That's why (as you'll see later) we often store in P2, P3 or P3, an address number which is one less than the number we want to jump to by using the XPPC instruction.

These pointer-register instructions of the 8060 are therefore a very useful method of going to a completely new address to load or store or to jump to a sub-routine. A pointer register can, for example, carry the starting address (less 1) of a piece of program which can be brought into

MPU's BY EXPERIMENT

action at any time by having the instruction XPPC for the correct pointer in the main program. Because this is an exchange instruction, the correct address of the main program ends up in the pointer register, so that we can return to the normal program again by repeating the XPPC instruction — it's usually done by jumping back to the previous XPPC. It's a particularly simple and effective method, though if you try to write really complex programs you'll wish you had more registers.

The Single Byters

Back to the old chip pan. We've nearly finished tasting the choice of instructions which this set-up can teach us, but we haven't yet looked at the single byte instructions, SHIFT and ROTATE. RESET and CANCEL, then load a data byte by using 11000100 PUSH 11110000 PUSH. The data byte 11110000 has been chosen as one which will be easily recognised again. Now for the next trick, set up 00011100 (SR) and PUSH three times. This instruction is the SHIFT RIGHT instruction — we can view the effect by using 11001000 PUSH 00000001 PUSH. As you'll see, the block of 1's has been right-shifted three places in its byte. This is an instruction which makes binary multiplication possible — but we're not going to try it on this machine! Another shift instruction, shift-with-carry/link (SRL) will put the bit in position 7 of the status register. Load up again with the same byte, 11110000, and shift right by using 00011100 and two PUSH operations. Now set the CY/L bit to 1 by using 00000011 PUSH, and put this bit into the accumulator by using SRL, 00011101 PUSH. View in the usual way.

The result shows that the block of 4 1's has been right-shifted by three places (two SR, one SRL) and the 1 from the carry/link has been moved into the highest order of the byte.

The ROTATE—RIGHT (RR) instruction also shifts bits around, bit by bit, but with a difference. Load up the data byte 00110011 by using the sequence 11000100 PUSH 00110011 PUSH. Now set up the RR code, 00011110 and use PUSH twice. Display the result in the usual way, and you'll find that the bits which were shifted out of the lowest places in the byte have now been moved into the highest places. A modified instruction, code 00011111, takes the carry/link bit into this chain, so that bit D0 is moved to CY/L, the bit in CY/L is moved to D7, and all the other bits on the accumulator are moved one place right on each RRL instruction. These shift and rotate instructions are particularly useful when four bits of a byte are to be selected for a hexadecimal display, since we can choose either the higher four or the lower four by suitable shift or rotate instructions.

An Advanced Machine

There are some facilities and instructions we haven't used, notably the interrupt system, because a complete run-through needs a number of steps which are better demonstrated on a more-advanced test-bed. The more advanced test-bed, as far as we're concerned, is the MK14, and we'll start on that next month. If you haven't yet received yours, or haven't yet assembled it, have patience — the articles will keep for a bit!

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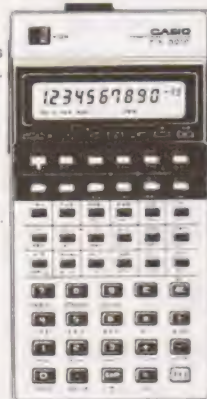
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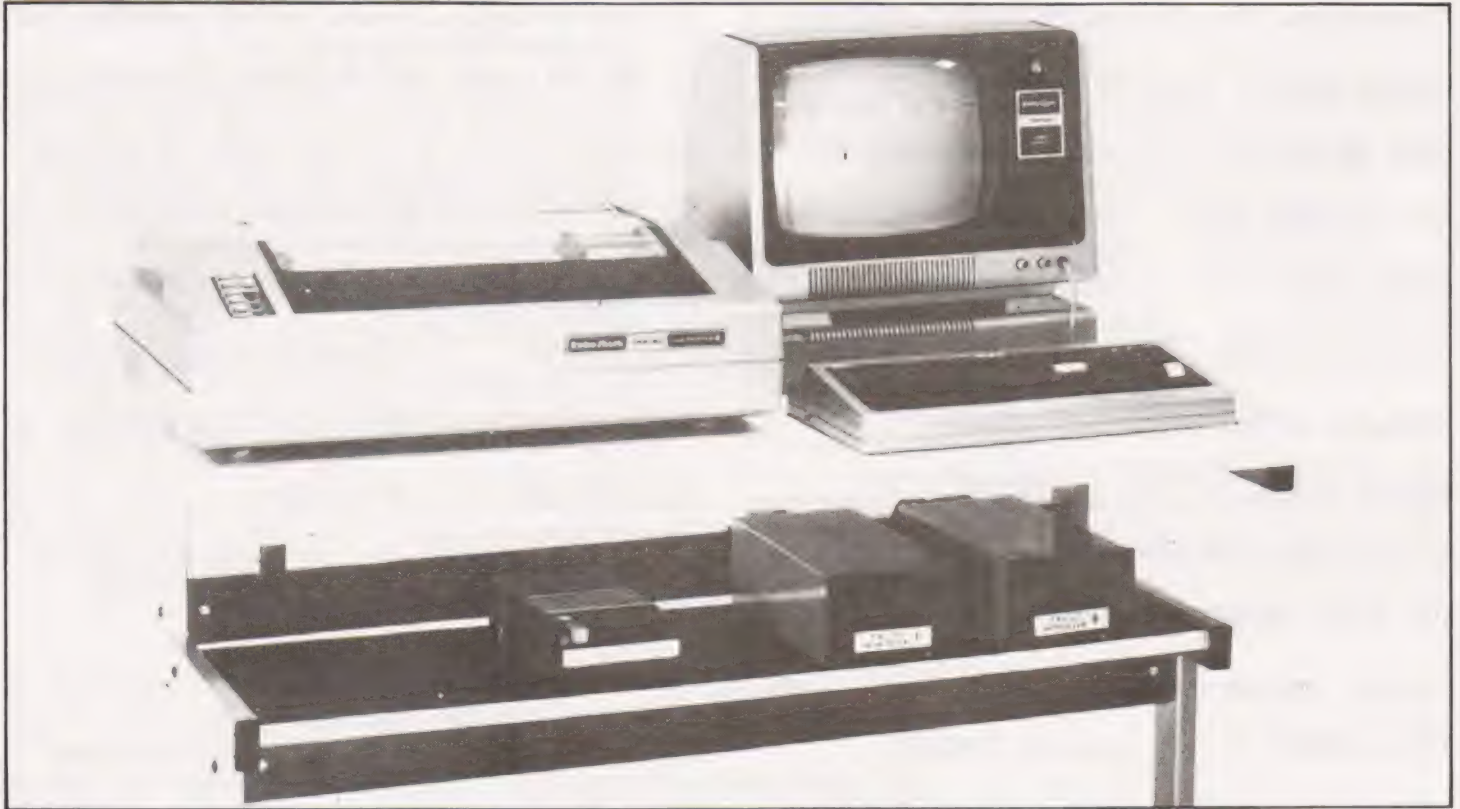
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A small business application for 16K TRS-80

This program which is written in TRS-80 level II disk BASIC, is another example of the use of the random file utility. It is simple to use and data is passed very quickly to and from the buffers. Full use is made of the provision for converting numeric values with the MKI\$, MKS\$, CVI and CVS functions so as to make maximum use of the 256 bytes available in each buffer. Integers are converted to occupy 2 bytes and single precision numbers to 4 bytes prior to fielding.

The program is self prompting, easy to use and gives a page format display on the VDU of the data relevant to each stock item. When in the 'read' mode a print-out is also given on the line printer which identifies logical record numbers to stock items, it also prints the quantities held of each item, the minimum holding, the item cost (each), the total stock cost value, and the total nett retail value. A reminder is given when the minimum holding quantity has been reached.

The minimum equipment requirements required to operate this program are as follows:—

- (A) TRS-80 16K LEVEL II WITH VISUAL DISPLAY UNIT
- (B) FLOPPY DISK DRIVE UNIT
- (C) EXPANSION INTERFACE
- (D) LINE PRINTER

Note: Two floppy disk drives are preferred, one to

accommodate the system diskette (especially if you are fortunate enough to have NEWDOS) the other can then be used solely for the program and data storage.

Operation

After entering the listed program via the keyboard, check for accuracy then save on disk using the file name 'STOCK/EVL' 1. Writing data.

- (a) Switch on the line printer and set (print switch) to 'PRINT'.
- (b) Load the program from disk then 'LIST' to see if it has loaded correctly. If all is in order type 'RUN' then press the (enter) key.
- (c) The prompt 'type 1 to write, 2 to read, 3 to quit' will be displayed. As this is the initial run of the program the 'WRITE' mode should be selected by typing A — 1 in answer to the prompt then press the (enter) key.
- (d) The prompt 'enter logical record number' is next to be displayed, answer this by typing A — 1 (as this will be the first data entry), then press the (enter) key.
- (e) The computer should now (run) as per the sample listing given below, prompting for entries whenever necessary.

SAMPLE LISTING OF DATA ENTRY FOR LOGICAL RECORD NO. 1.

TYPE 1 TO WRITE, 2 TO READ, 3 TO QUIT ?
1 <ENTER>

SUB RECORD NUMBER 0

PHYSICAL RECORD NUMBER 1

STOCK NUMBER ? 261140 <ENTER>

DESCRIPTION ? MUSIC CENTRE <ENTER>

NUMBER HELD ? 6 <ENTER>

DATE CHECKED ? 07/28/79 <ENTER>

MIN HOLDING ? 2 <ENTER>

COST PRICE ? 200.15 <ENTER>

V. A. T % ? 15 <ENTER>

HANDLING CHARGE % ? 1.25 <ENTER>

PROFIT MARGIN % ? 33 <ENTER>

ENTER LOGICAL RECORD NUMBER ? 2 <ENTER>

SUB RECORD NUMBER 1

PHYSICAL RECORD NUMBER 1

STOCK NUMBER ? 261141 <ENTER>

DESCRIPTION ? REC. PLAYER GC240 <ENTER>

NUMBER HELD ? 4 <ENTER>

DATE CHECKED ? 07/28/79 <ENTER>

MIN HOLDING ? 4 <ENTER>

COST PRICE ? 39.75 <ENTER>

V. A. T % ? 15 <ENTER>

HANDLING CHARGE % ? 1.25 <ENTER>

PROFIT MARGIN % ? 33 <ENTER>

ENTER LOGICAL RECORD NUMBER ? 0 <ENTER>

Note 1. We have assumed here that all our data has been entered and have answered the above prompt by typing in A - 0 (zero). The prompt 'type 1 to write, 2 to read, 3 to quit' will be displayed, answer by typing A - 3 to exit press the (enter) key, and when the 'end of program' (ready) is displayed withdraw the diskette and store in a safe place.

However, should you wish to enter the 'READ' mode, answer the prompt by typing A - 2 then press the (enter) key. Follow the procedure given at paragraph 2.

2. Reading data from disk.

(a) Switch on the line printer and set 'print switch' to 'PRINT'. (This assumes printer not already on).

(b) Load the program 'STOCK/EVL' from disk, then list. If it has loaded correctly type 'RUN' then press the (enter) key.

(c) The prompt type 1 to write, 2 to read, 3 to quit

will be displayed. Assume that we are reading data and answer the prompt by typing A - 2.

(d) The prompt 'enter the logical record number?' is next to be displayed. At this point you may select the record number for any of the data entries inputted whilst operating in the write mode, but as we have only input two entries answer the prompt by typing A - 1 then press the (enter) key. The computer will then output data as follows:

ENTER LOGICAL RECORD NUMBER ? 1 <ENTER>

STOCK NUMBER 261140 MUSIC CENTRE

NUMBER HELD 6 MIN HOLDING 2

DATE CHECKED 07/28/79

COST PRICE (EACH) 200.15

VAT (PERCENT) 15

HANDLING CHARGE % 1.25

PROFIT MARGIN % 33

RETAIL PRICE (LESS VAT) 268.70

V. A. T. DUE AT 15 % 40.31

GROSS RETAIL PRICE 309.01

RETAIL VALUE STOCK HELD (EXCL VAT) 1612.20

V. A. T. DUE ON STOCK HELD 241.83

COST VALUE OF STOCK HELD 1200.90

DO YOU WISH TO CONTINUE TO READ DATA
(YES OR NO) ?

YES <ENTER>

STOCK NUMBER 261141 REC. PLAYER GC240

NUMBER HELD 4 MIN HOLDING 4

DATE CHECKED 07/28/79

COST PRICE (EACH) 39.75

V. A. T % 15

HANDLING CHARGE % 1.25

PROFIT MARGIN % 33

RETAIL PRICE (LESS VAT) 53.36

V. A. T DUE AT 15% 8.00

STOCK CONTROL

GROSS RETAIL PRICE 61.36

RETAIL VALUE STOCK HELD (EXCL VAT) 213.44

V. A. T DUE ON STOCK HELD 32.02

** RE-ORDER REQUIRED FOR STOCK ITEM 261141 **

COST VALUE STOCK HELD 159.00

Note that in this case a reminder is displayed to indicate that the minimum holding quantity has been reached. This reminder will flash on and off for a few seconds before continuing to the next prompt viz.

Do you wish to continue to read data (yes or no)?

We only entered two blocks of data therefore, if we answer yes to this prompt, the screen will clear and 'D A T A O U T P U T C O M P L E T E D' will appear, this will be followed a few seconds later by 'type 1 to write, 2 to read, 3 to quit?' answer by typing A - 3 to exit the program.

'End of program'

'Ready'

)'

is finally displayed and the diskette should be stored in a safe place for future use.

In addition to visual read out the line printer will, at the same time print-out data in the following format.

QTY HLD MIN HDG ITEM COST TOTAL STOCK

		EACH	COST VALUE
6	2	200.15	1200.90
4	4	39.75	159.00

This identifies logical record numbers to stock item numbers, and gives other useful information.

A Word Of Caution

One of the great advantages of random files is that they are easily updated by overwriting previous entries, so then an incorrect answer to the prompt 'type 1 to write, 2 to read, 3 to quit?' will result in the erasure of your stored data if it is answered by typing A - 1 instead of A - 2. If this happens type A - 0 to the next prompt and start afresh.

10 REM THIS IS A STOCK CONTROL AND EVALUATION PROGRAM

15 REM IT IS SELF PROMPTING AND WILL REQUEST INPUT DATA WHEN

20 REM REQUIRED.

25 REM TWO METHODS ARE AVAILABLE TO PROVIDE AN EXIT FROM THE

30 REM PROGRAM :-

35 REM 1. TO THE PROMPT 'ENTER LOGICAL RECORD NUMBER' ANSWER

40 REM BY TYPING A - 0 (ZERO) IF NO MORE DATA IS TO BE

45 REM ENTERED.

50 REM 2. TO THE PROMPT 'TYPE 1 TO WRITE, 2 TO READ, 3 TO QUIT'

60 REM ANSWER BY TYPING A - 3.

65 REM RIGID ADHERENCE TO THIS PROCEDURE WILL ENSURE PROTECTION

70 REM OF DATA PREVIOUSLY ENTERED.

75 REM ENTER ITEM STOCK NUMBER USING A 6 FIGURE FORMAT, (NO

80 REM SPACES).

85 REM ENTER ITEM DESCRIPTION USING A MAXIMUM OF 18 CHARACTERS

90 REM (OR LESS).

95 REM DELETE ALL REM STATEMENTS WHEN PROGRAM FAMILIARISATION

100 REM IS COMPLETE. THIS ACTION WILL CONSERVE MEMORY.

105 PRINT:CLS:PRINT

110 PRINT" ** STOCK CONTROL AND EVALUATION PROGRAM ** "

125 FOR I = 1 TO 500:NEXT I:CLS

130 LPRINT"LR #";TAB(8)"STOCK #";TAB(17)"QTY HLD";TAB(27)"MIN HDG";

135 LPRINT TAB(37)"ITEM COST";TAB(49)"TOT. STOCK";TAB(62)"TOT. NETT"

140 LPRINT TAB(39)"EACH";TAB(49)"COST VALUE";TAB(62)"RETAIL VAL"

150 LPRINT" "

160 PRINT:CLR3000:CLS:CLOSE

170 PRINT:INPUT"TYPE 1 TO WRITE, 2 TO READ, 3 TO QUIT";N

180 OPEN "R",1,"EVAL"

190 ON N GOTO 200,400,990

200 PRINT:INPUT"ENTER LOGICAL RECORD NUMBER ";LR:PRINT

210 IF LR = 0 THEN 160

220 GOSUB 800:PR=INT((LR-1)/5)+1

230 GET 1,PR:PRINT"PHYSICAL RECORD NUMBER ";PR:PRINT

240 PRINT"STOCK NUMBER";TAB(20);:INPUT N\$:LSET NS\$ = N\$

250 PRINT"DESCRIPTION";TAB(20);:INPUT E\$:LSET ES\$ = E\$

260 PRINT"NUMBER HELD";TAB(20);:INPUT H\$:LSET HD\$ =MKI\$(H\$)



The TRS-80 tractor fed printer, suitable for business stationery.

```

270 PRINT"DATE CHECKED";TAB(20);:INPUT T$:LSET TK$ = T$
280 PRINT"MIN HOLDING";TAB(20);:INPUT M$:LSET MN$ = MKI$(M%)
290 PRINT"COST PRICE";TAB(20);:INPUT C!:LSET CP$ = MKS$(C!)
300 PRINT"V. A. T (PERCENT)";TAB(20);:INPUT V$:LSET VT$=MKI$(V%)
310 PRINT"HANDLING CHARGE %";TAB(20);:INPUT H!:LSET HC$=MKS$(H!)
320 PRINT"PROFIT MARGIN %";TAB(20);:INPUT P$:LSET PT$ = MKI$(P%)
330 PUT 1,PR:GOTO 200
400 PRINT:INPUT"ENTER LOGICAL RECORD NUMBER ";LR
410 IF LR = 0 THEN 160 ELSE 450
420 PRINT:CLS:PRINT CHR$(23)"DATA OUTPUT COMPLETED"
430 FOR I = 1 TO 500 : NEXT I
440 CLS:GOTO160
450 GOSUB 800:PR=INT((LR-1)/5)+1
460 GET 1,PR
470 V$ = "#####.##"
480 IF VAL(NS$) = 0 THEN 420 ELSE 490
490 H=CVS(HC$):P=CVI(PT$):X=CVI(HD$):Y=CVI(MN$):Z=CVS(CP$)
500 V=CVI(VT$): H=H/100:P=P/100:V=V/100
510 U=INT((Z+Z*H+Z*P)*100+.5)/100
520 S=INT(U*V*100+.5)/100:R=INT(U*X*100+.5)/100
530 Q=INT(X*Z*100+.5)/100
540 PRINT"STOCK NO. ";TAB(20);NS$:TAB(32);ES$
560 PRINT"NUMBER HELD";TAB(20);X:TAB(32)"MIN HOLDING ";Y
570 PRINT"DATE CHECKED";TAB(20);TK$
590 PRINT"COST PRICE (EACH)";TAB(40)USING V$;Z
600 PRINT"V. A. T %";TAB(20);V*100
610 PRINT"HANDLING CHARGE %";TAB(20);H*100
620 PRINT"PROFIT MARGIN %";TAB(20);P*100
630 PRINT"RETAIL PRICE (LESS V. A. T)";TAB(40)USING V$;U
640 PRINT"VAT DUE AT ";V*100;"%";TAB(40)USING V$;S
650 PRINT"GROSS RETAIL PRICE";TAB(40)USING V$;U+S
660 PRINT"RETAIL VALUE STOCK HELD(EXCL VAT)";TAB(40)USING V$;R
670 PRINT"V. A. T DUE ON STOCK HELD";TAB(40)USING V$;INT(U*X*V*100+.5)/100
680 PRINT"COST VALUE STOCK HELD";TAB(40)USING V$;Q

```


STOCK CONTROL

```

690 GOSUB 1000
700 IF X=Y OR X<Y THEN GOSUB 900
710 LR = LR+1
720 PRINT:INPUT"DO YOU WISH TO CONTINUE TO READ DATA (YES OR NO)";F$
725 IF F$ = "YES" THEN 410
726 IF F$ = "NO" THEN 160
727 PRINT" **** PLEASE ANSWER EITHER YES OR NO ****":GOTO720
740 END
800 SR=LR-5*INT((LR-1)/5)-1
810 FIELD 1,SR*50 AS D$,6 AS NS$,18 AS ES$,2 AS HD$,10 AS TK$,2 AS MN$,4 AS CP$,2 AS VT$,
    4 AS HC$,2 AS PT$
820 RETURN
900 FOR J=1TO15:PRINT@896,"**** RE-ORDER STOCK ITEM ";NS$;" ****";:FOR K=1 TO 50:NEXT
902 PRINT@896,"                                ":FOR K=1TO50:NEXTK,J

904 PRINT@832,"COST VALUE STOCK HELD";TAB(40)USING V$;Q
910 LPRINT"          ***** RE-ORDER REQUIRED FOR STOCK ITEM ";NS$;" *****"
920 RETURN
990 PRINT:CLS:PRINT"          **** END OF PROGRAM ****          "
995 CLOSE
999 END
1000 LPRINT TAB(0);LR:TAB(8);NS$:TAB(17);X:TAB(27);Y;
1005 LPRINT TAB(37) USING V$;Z:LPRINT TAB(49) USING V$;Q;
1010 LPRINT TAB(62) USING V$;R
1015 RETURN
    
```

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State
CLEAF
GOTO
NEXT
REM

Exp
Opr
-

f

Su

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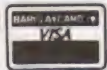
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LOSING YOURSELF IS FUN

Next month we present what we hope is the ultimate maze game. The program designs a maze in plan and then projects it in 3D so you actually walk through it, hopefully finding the way out! Written in BASIC for the Triton it is fully documented for conversion to other systems. Once you get into your micro you may never get out so beware.

The famous game of Pontoon has been written in BASIC and we present it in next month's issue. A better way to spend Christmas afternoon than watching repeats, on telly that is. Gamble your 50p on next month's issue for hours of fun.

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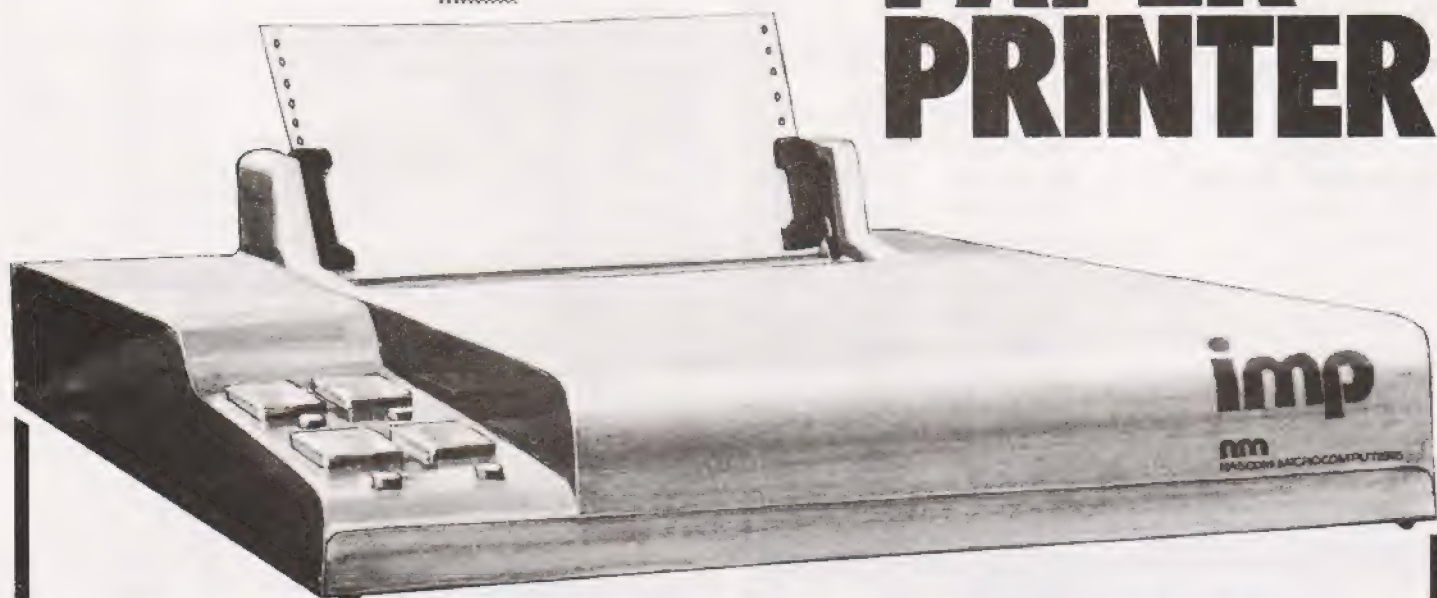
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A reader's experience in the microcomputer jungle

Three months ago I knew nothing about computers. Now, after just nine weeks of proud ownership, I am writing programs, not to professional standards of course, but they do work. My biggest problem was choosing the right system in the first place.

The Beginning Of The Search

It all started when I read a magazine article about silicon chips. For around £500 one could buy a computer which would play chess, process statistical information and even help with income tax computations. I was hooked!

Finding out about the computers available was difficult for a person with a non-technical background, such as myself. The brochures I acquired were almost incomprehensible to the layman — full of bits and bytes, ROMs and RAMs. This may seem a trivial complaint, but I suspect that quite a few readers of this magazine are not too comfortable with all the jargon. I've still not figured out what a monitor does.

Nevertheless, after ploughing through them and two issues of ETI and Computing Today, I discovered enough to make a short list of the features I was interested in. These included a powerful but easy to use BASIC and good overall design. The availability of a wide range of cheap software was important to me as a beginner. Price, graphics capability and general ease of use were my other main criteria. I also wanted the ability to expand the system as my knowledge grew.

Specify The Requirement

This may seem a fairly obvious specification, yet I found it a useful yardstick for comparison. It enabled me to dismiss three well-known systems right away. An experienced programmer would doubtless have had a completely different set of priorities and might well have reached a different decision. The important thing is to formulate what you want in advance.

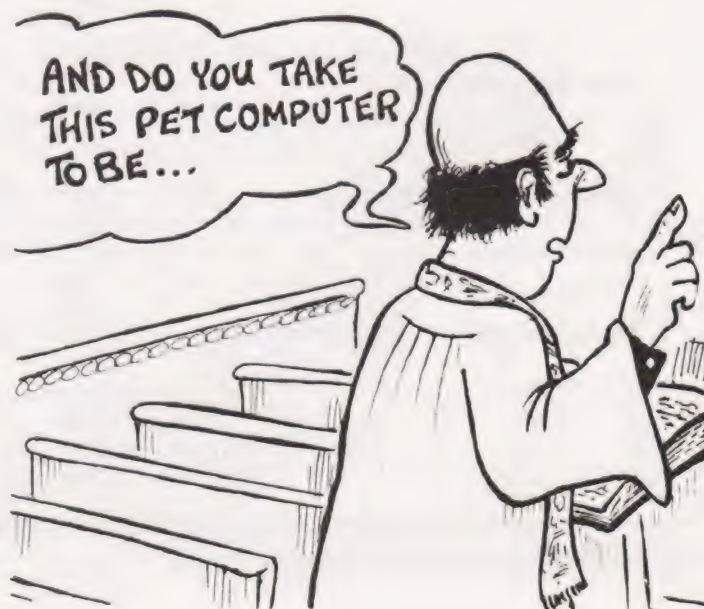
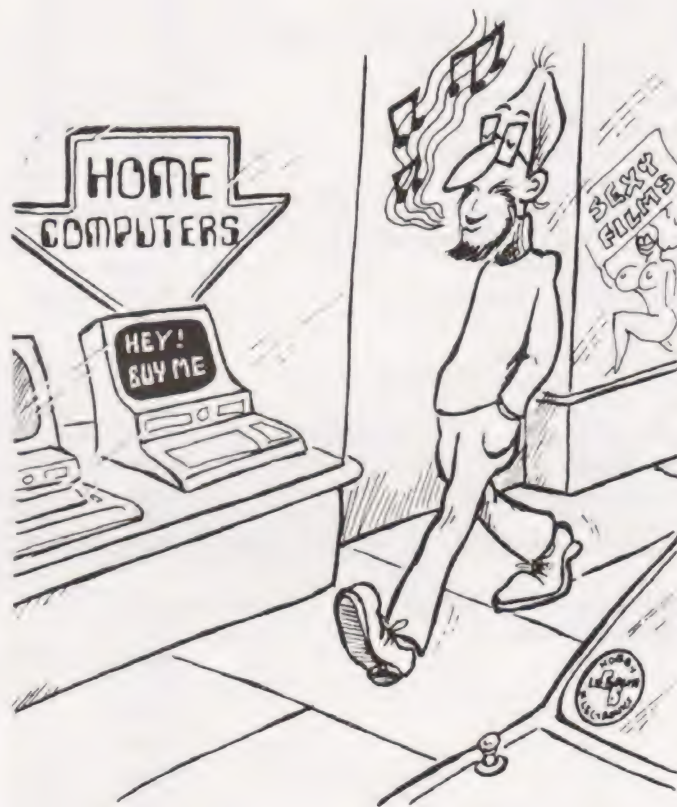
Next I visited four computer shops in London's Tottenham Court Road, where I saw demonstrations of six systems costing £1200 or less for the basic package.

The demonstrations, with the honourable exception of Eurocalc, consisted in each case of a quick recital of jargon followed by a run through a program which I did not always fully understand. Fortunately, I was left alone with the three computers which came closest to my ideal specification.

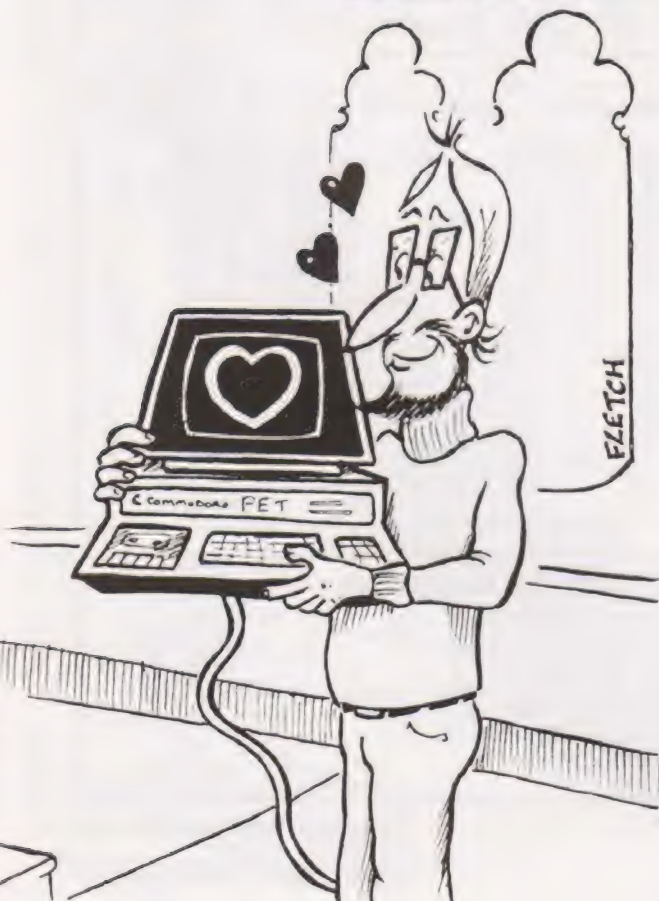
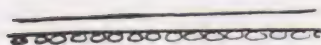
The Available Choice

The first was an Apple II costing £985 for a smart attache case type keyboard unit which actually contained the whole computer. It had marvellous colour graphics, which I found a little difficult to use. These, the salesman assured me, could easily be mastered with practice. However, when the cost of the cassette recorder and various bits and pieces to attach it to a colour television had been added, the total cost came to £1,500 — more than I could really afford to spend. A speech synthesiser was about to be released also — too bad!

I played a good game of Microchess on a Tandy TRS-80. My immediate impression was that the computer system was less well designed than the others, although I liked the feel of the keyboard. The keyboard unit itself, cassette deck and TV monitor, were all strung together with



MICROCHOICE



a mass of wires. Expansion involved yet another box. I noticed that the salesman also had to fiddle with the volume and tone controls in order to get the tapes to load satisfactorily. Even with my limited book-acquired knowledge of programming, it was clear that the TRS-80's level one BASIC was vastly inferior even to that of the Exidy Sorcerer. For an additional charge, level two BASIC could be installed on the TRS-80, but even so the Apple and PET basics seemed easier to use. For example, editing a mistake in a PET program, it was necessary only type the correct character over the erroneous one and then press the return key. With most of the other systems one had to re-type the whole line.

The last machine I tried was the Commodore PET. Every store I visited had racks displaying a wide variety of PET programs by Commodore and PETSOFT. I was told that there was relatively little software available for the other systems.

Love At First Byte?

I fell in love with the PET instantly. It looks so futuristic for one thing, self contained in its own steel case. I started to tell the salesman that the TRS-80 had a much better keyboard than the PET's fiddly little calculator type keys. "A traditional complaint, sir" he said "come this way". And there, at the back of the shop, was a smart looking PET with a proper, typewriter style, keyboard. It was the new 16K model retailing at £680 inc. VAT, plus £54 for the cassette recorder.

Looking down my list it was clear that the PET came closest to meeting my needs. This has been borne out by subsequent experience, although I still also like the Apple. In retrospect, I would probably add another item to my list: documentation. Commodore's is poor, although I subsequently bought PETSOFT's work books at £15 per set of 5. These filled the need.

Instead of a discount the shop gave me some free software. Neither of the Commodore games programs worked properly. I eventually discovered this was due to a change in the type of ROM memory chips used. The PETSOFT Addressbook and Restaurant Finder programs ran perfectly, and I subsequently ordered some more programs from them by telephone, using my Barclaycard. These arrived by first class post the following day.

Learning The Language

I have read several books on BASIC, of which *Illustrating BASIC* by Donald Alcock was the most helpful. On the whole though I find the magazines more helpful. In addition to 'Computing Today', I like the Commodore magazine, which seems expensive at £10 for 5 issues a year. There is also an independent PET User Group who publish a bi-monthly newsletter; membership is just £3 p.a. I have also seen newsletters produced by the TRS-80 and Apple Groups which seem equally good.

Undoubtedly the most productive learning method has been sheer trial and error. I have had quite a lot of help from other PET users and owners of different systems. For this reason I would recommend membership of the Amateur Computer Club, who have local groups operating in most parts of the country.

Conclusion

Looking back, I regret the absence of an independent information source giving unbiased advice on the different systems available. Right now I am attempting to write a program that will attempt to match people and applications to the right micro system. It looks like being a long job!

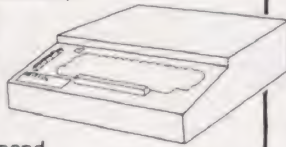
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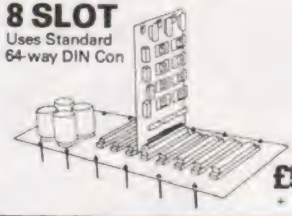
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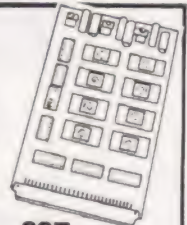


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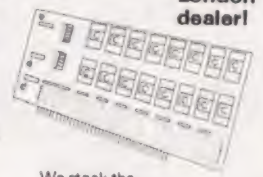
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SN74LS05N	26	SN74LS73N	35	SN74LS151N	85	SN74LS240N	220	SN74LS366N	65
SN74LS06N	20	SN74LS75N	46	SN74LS153N	60	SN74LS241N	190	SN74LS366N	65
SN74LS09N	22	SN74LS76N	35	SN74LS154N	160	SN74LS242N	190	SN74LS367N	65
SN74LS10N	18	SN74LS78N	35	SN74LS156N	125	SN74LS243N	190	SN74LS368N	65
SN74LS11N	26	SN74LS78AN	15	SN74LS156N	125	SN74LS244N	210	SN74LS373N	175
SN74LS12N	25	SN74LS85N	110	SN74LS157N	60	SN74LS245N	360	SN74LS374N	175
SN74LS13N	55	SN74LS86N	40	SN74LS158N	99	SN74LS247N	125	SN74LS375N	72
SN74LS14N	89	SN74LS90N	66	SN74LS160N	115	SN74LS248N	190	SN74LS377N	175
SN74LS15N	25	SN74LS91N	99	SN74LS161N	115	SN74LS249N	130	SN74LS379N	132
SN74LS20N	35	SN74LS92N	90	SN74LS162N	115	SN74LS251N	145	SN74LS380N	385
SN74LS21N	35	SN74LS93N	65	SN74LS163N	90	SN74LS252N	125	SN74LS380N	385
SN74LS22N	26	SN74LS96AN	85	SN74LS164N	150	SN74LS257N	140	SN74LS386N	57
SN74LS26N	29	SN74LS96N	175	SN74LS165N	170	SN74LS258N	95	SN74LS390N	198
SN74LS27N	25	SN74LS98N	39	SN74LS166N	175	SN74LS259N	39	SN74LS393N	150
SN74LS28N	25	SN74LS100N	39	SN74LS168N	195	SN74LS260N	39	SN74LS395N	180
SN74LS30N	25	SN74LS112N	39	SN74LS169N	195	SN74LS261N	350	SN74LS396N	170
SN74LS32N	27	SN74LS113N	44	SN74LS170N	250	SN74LS266N	39	SN74LS396N	275
SN74LS33N	27	SN74LS114N	44	SN74LS173N	220	SN74LS273N	185	SN74LS399N	160
SN74LS37N	29	SN74LS122N	75	SN74LS174N	115	SN74LS279N	29	SN74LS424N	450
SN74LS38N	29	SN74LS123N	90	SN74LS175N	105	SN74LS280N	75	SN74LS445N	125
SN74LS40N	25	SN74LS124N	150	SN74LS181N	275	SN74LS283N	180	SN74LS447N	125
SN74LS42N	29	SN74LS125N	85	SN74LS183N	175	SN74LS283N	180	SN74LS460N	195
SN74LS43N	29	SN74LS126N	85	SN74LS184N	175	SN74LS283N	180	SN74LS460N	195
SN74LS48N	46	SN74LS132N	75	SN74LS185N	175	SN74LS283N	180	SN74LS460N	195
SN74LS49N	109	SN74LS133N	39	SN74LS186N	175	SN74LS283N	180	SN74LS460N	195

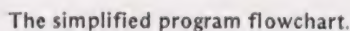
So, there's nothing for it, but to search each of these three buildings, and the street, in the hope of spotting the outlaws before they see you. Of course if you do spot an outlaw first, then you can get a shot in before he knows you're there. However, the other side might become aware of your presence first, in which case you will hear a pistol shot resound before you have the chance to do anything about it. Obviously, the greater the number of outlaws in a particular location, the greater your chances are of spotting one of them first, although, by the same token, the greater their chances of getting in the beginning shot. Gunfights proceed with shots coming alternatively from you and the enemy; each time you hear a bullet whistle safely by, you have the opportunity to return fire, or duck aside unseen into another building, to have a look around there. A similar choice is open to you when you first spy out a hidden gunman. On average, being a crack marksman, your slugs find their targets, three out of every four shots, compared with one out of four, for the bandits.

Sometimes, though, a disquieting silence may hang over the place you are searching, and you can see no sign of any bandits. This may well mean that the place is deserted, or that you have finished off the last outlaw hiding out there. It may, however, mean that the bandits are just lying low, and haven't noticed you yet. Remaining in that location, or subsequently returning to it, may have a quite different result.

Machine

The program is best recorded on two magnetic cards, (both program memory, and some data registers, have to be entered at the start of play).

000	76	LBL
001	16	R*
002	42	STD
003	07	07
004	69	DP
005	37	37
006	73	RC*



007	07	07	060	10	10	113	95	=	167	69	DP
008	69	DP	061	69	DP	114	32	XIT	168	03	03
009	04	04	062	04	04	115	01	1	169	43	RCL
010	69	DP	063	05	5	116	77	GE	170	27	27
011	37	37	064	03	3	117	68	NOP	171	69	DP
012	43	RCL	065	98	ADV	118	76	LBL	172	04	04
013	07	07	066	17	B'	119	37	P/R	173	18	C'
014	76	LBL	067	69	DP	120	02	2	174	98	ADV
015	17	B'	068	00	00	121	04	4	175	01	1
016	42	STD	069	06	6	122	16	A'	176	22	INV
017	07	07	070	09	9	123	98	ADV	177	74	SM*
018	73	RC*	071	42	STD	124	25	CLR	178	48	48
019	07	07	072	07	07	125	91	R/S	179	43	RCL
020	69	DP	073	18	C'	126	76	LBL	180	32	32
021	03	03	074	98	ADV	127	69	DP	181	50	IXI
022	69	DP	075	19	D'	128	69	DP	182	85	+
023	37	37	076	65	*	129	00	00	183	43	RCL
024	76	LBL	077	04	4	130	69	DP	184	37	37
025	18	C'	078	95	=	131	20	20	185	50	IXI
026	73	RC*	079	32	XIT	132	01	1	186	85	+
027	07	07	080	01	1	133	02	2	187	43	RCL
028	69	DP	081	77	GE	134	17	B'	188	42	42
029	02	02	082	68	NOP	135	01	1	189	50	IXI
030	69	DP	083	61	GTD	136	06	6	190	85	+
031	37	37	084	37	P/R	137	03	3	191	43	RCL
032	73	RC*	085	76	LBL	138	02	2	192	47	47
033	07	07	086	11	A	139	04	4	193	50	IXI
034	69	DP	087	19	D'	140	03	3	194	95	=
035	01	01	088	65	*	141	03	3	195	32	XIT
036	69	DP	089	04	4	142	01	1	196	01	1
037	05	05	090	95	=	143	69	DP	197	77	GE
038	92	RTN	091	32	XIT	144	04	04	198	88	DMS
039	76	LBL	092	03	3	145	43	RCL	199	61	GTD
040	19	D'	093	77	GE	146	00	00	200	24	CE
041	36	PGM	094	69	DP	147	69	DP	201	76	LBL
042	15	15	095	69	DP	148	06	06	202	68	NOP
043	71	SBR	096	00	00	149	98	ADV	203	02	2
044	88	DMS	097	03	3	150	06	6	204	08	8
045	92	RTN	098	00	0	151	08	8	205	16	A'
046	76	LBL	099	02	2	152	16	A'	206	76	LBL
047	86	STF	100	04	4	153	05	5	207	98	ADV
048	05	5	101	03	3	154	00	0	208	25	CLR
049	06	6	102	06	6	155	42	STD	209	98	ADV
050	69	DP	103	03	3	156	07	07	210	98	ADV
051	00	00	104	06	6	157	02	2	211	98	ADV
052	98	ADV	105	69	DP	158	02	2	212	98	ADV
053	17	B'	106	02	02	159	00	0	213	91	R/S
054	98	ADV	107	69	DP	160	00	0	214	76	LBL
055	25	CLR	108	05	05	161	03	3	215	88	DMS
056	91	R/S	109	98	ADV	162	07	7	216	02	2
057	76	LBL	110	19	D'	163	02	2	217	52	EE
058	22	INV	111	65	*	164	03	3	218	09	9
059	43	RCL	112	04	4	165	01	1	219	22	INV
						166	07	7			

HIGH NOON

220	52	EE	273	37	37	326	14	14
221	69	DP	274	42	STD	327	69	DP
222	04	04	275	42	42	328	01	01
223	01	1	276	42	STD	329	43	RCL
224	05	5	277	47	47	330	16	16
225	98	ADV	278	19	D'	331	69	DP
226	17	B'	279	65	X	332	02	02
227	98	ADV	280	01	1	333	43	RCL
228	69	DP	281	00	0	334	08	08
229	00	00	282	85	+	335	69	DP
230	03	3	283	01	1	336	03	03
231	06	6	284	95	=	337	69	DP
232	01	1	285	59	INT	338	05	05
233	07	7	286	42	STD	339	98	ADV
234	01	1	287	00	00	340	76	LBL
235	07	7	288	76	LBL	341	15	E
236	03	3	289	81	RST	342	05	5
237	06	6	290	19	D'	343	85	+
238	69	DP	291	65	X	344	76	LBL
239	02	02	292	04	4	345	14	D
240	69	DP	293	95	=	346	05	5
241	05	05	294	59	INT	347	85	+
242	01	1	295	65	X	348	76	LBL
243	08	8	296	05	5	349	13	C
244	42	STD	297	85	+	350	05	5
245	07	07	298	03	3	351	85	+
246	43	RCL	299	02	2	352	76	LBL
247	00	00	300	95	=	353	12	B
248	99	PRT	301	42	STD	354	03	3
249	32	XIT	302	07	07	355	02	2
250	01	1	303	01	1	356	95	=
251	67	EQ	304	74	SM*	357	42	STD
252	95	=	305	07	07	358	48	48
253	06	6	306	97	DSZ	359	98	ADV
254	00	0	307	00	00	360	16	A'
255	33	X ²	308	81	RST	361	98	ADV
256	85	+	309	69	DP	362	76	LBL
257	76	LBL	310	00	00	363	24	CE
258	95	=	311	02	2	364	69	DP
259	43	RCL	312	98	ADV	365	00	00
260	19	19	313	17	B'	366	19	D'
261	95	=	314	07	7	367	65	X
262	69	DP	315	16	A'	368	04	4
263	03	03	316	98	ADV	369	95	=
264	18	C'	317	06	6	370	32	XIT
265	61	GTO	318	04	4	371	73	RC*
266	98	ADV	319	16	A'	372	48	48
267	76	LBL	320	06	6	373	77	GE
268	10	E'	321	08	8	374	86	STF
269	25	CLR	322	16	A'	375	19	D'
270	42	STD	323	69	DP	376	65	X
271	32	32	324	00	00	377	04	4
272	42	STD	325	43	RCL	378	95	=

379	32	XIT	3230243122.	06	3637132624.	38
380	73	RC*	0.	07	3122003513.	39
381	48	48	1700362645.	08	2427353213.	40
382	65	X	0.	09	1600363731.	41
383	01	1	3623323700.	10	0.	42
384	93	.	2324300016.	11	3032361745.	43
385	05	5	1713167320.	12	2431220016.	44
386	95	=	2051.	13	3243310036.	45
387	77	GE	2324222300.	14	3735171737.	46
388	22	INV	3132323151.	15	0.	47
389	76	LBL	2431003723.	16	0.	48
390	89	π	161713.	17	3231573313.	49
391	69	OP	1600141331.	18	3515232431.	50
392	00	00	1624370073.	19	36411616.	51
393	05	5	2332370027.	20	1731003324.	52
394	09	9	1713160043.	21	3637322700.	53
395	98	ADV	2324363727.	22	3241372713.	54
396	17	B'	1736001445.	23	4300243100.	55
397	98	ADV	4040404532.	24	3624222337.	56
398	25	CLR	4100142437.	25	41311713.	57
399	92	RTN	1700372317.	26	3645003624.	58
			16413637.	27	2717311517.	59
			24314217.	28	2437653600.	60
			3637242213.	29	1331002332.	61
			3724312200.	30	4135003732.	62
			1413312600.	31	31323231.	63
	0.	00	0.	32	1331160037.	64
4317271532.	01		3313152431.	33	2317003641.	65
3017003732.	02		2200353241.	34	3100361532.	66
2241313633.	03		3116003613.	35	3515231736.	67
4135003732.	04		2732323100.	36	35243122.	68
4331574345.	05		0.	37	3600324137.	69

DATA MEMORIES;
ALSO TO BE ENTERED
AT THE START OF THE
GAME.

User Instructions

1. To start the game, press 2nd E; and go to 2
2. (a) If "UNEASY SILENCE" is printed (after introductory messages) then, if it is desired to try bank, press B, Saloon, press C and go to 2. Railroad Station, press D, or remain in street, press E.
- (b) If an outlaw is in sight, the above options are open, in addition to that of shooting at him — press A and go

WELCOME TO
GUNSPUR TOWN, WYOMING

IT'S AN HOUR TO NOON
AND THE SUN SCORCHES
HIGH IN THE SKY

MOSEYING DOWN STREET

OUTLAW IN SIGHT

A
SHOT HIM DEAD? -

1. DOWN

to 3.

3. If a sudden pistol shot rings out, or if you miss on shooting, then if you bite the dust, the game has obviously ended, but if hot lead whistles by, then you have another chance, and so, go to 2(b).
4. If "—*HIGH NOON*—" etc, is printed, the game is terminated, all the bandits are dead, and you have won!

AND THE SUN SCORCHES
ON, PARCHING THE DUST

UNEASY SILENCE

C
PACING ROUND SALOON

SUDDEN PISTOL SHOT
RINGS OUT

...YOU BITE THE DUST

HIGH NOON

WELCOME TO
GUNSPUR TOWN, WYOMING

IT'S AN HOUR TO NOON
AND THE SUN SCORCHES
HIGH IN THE SKY

MOSEYING DOWN STREET

UNEASY SILENCE

C
PACING ROUND SALOON

OUTLAW IN SIGHT

A
MISS

HOT LEAD WHISTLES BY

A
SHOT HIM DEAD? -
1. DOWN

AND THE SUN SCORCHES
ON, PARCHING THE DUST

OUTLAW IN SIGHT

A
SHOT HIM DEAD? -
2. DOWN

AND THE SUN SCORCHES
ON, PARCHING THE DUST

UNEASY SILENCE

B
INVESTIGATING BANK

OUTLAW IN SIGHT

A
SHOT HIM DEAD? -
3. DOWN

AND THE SUN SCORCHES
ON, PARCHING THE DUST

UNEASY SILENCE

D
STAKING RAILROAD STN

UNEASY SILENCE

C
PACING ROUND SALOON

UNEASY SILENCE

D
STAKING RAILROAD STN

OUTLAW IN SIGHT

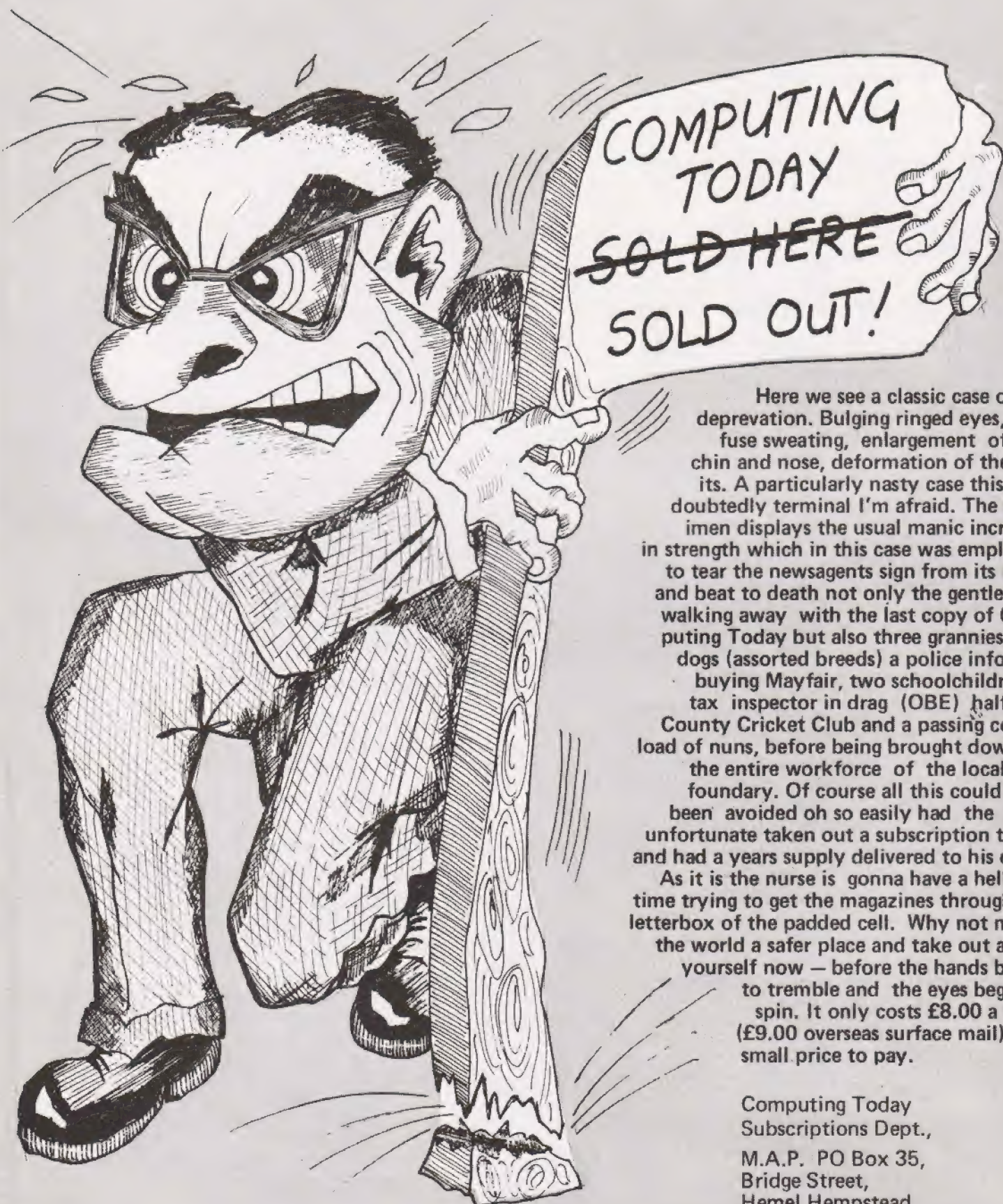
A
SHOT HIM DEAD? -
4. DOWN

AND THE SUN SCORCHES
ON, PARCHING THE DUST

--*HIGH NOON*--

SEES
4.
DEAD BANDITS?

ARRRGGGHHH.....



Here we see a classic case of CT depredation. Bulging ringed eyes, profuse sweating, enlargement of the chin and nose, deformation of the digits. A particularly nasty case this. Undoubtedly terminal I'm afraid. The specimen displays the usual manic increase in strength which in this case was employed to tear the newsagents sign from its roots and beat to death not only the gentleman walking away with the last copy of Computing Today but also three grannies, five dogs (assorted breeds) a police informer buying Mayfair, two schoolchildren, a tax inspector in drag (OBE) half the County Cricket Club and a passing coach load of nuns, before being brought down by the entire workforce of the local iron foundry. Of course all this could have been avoided oh so easily had the poor unfortunate taken out a subscription to CT and had a years supply delivered to his door. As it is the nurse is gonna have a hell of a time trying to get the magazines through the letterbox of the padded cell. Why not make the world a safer place and take out a sub yourself now — before the hands begin to tremble and the eyes begin to spin. It only costs £8.00 a year (£9.00 overseas surface mail) — a small price to pay.

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BUY nascom-2 NOW AND GET A **FREE** 16K RAM BOARD

The lack of availability of the MK4118 RAMs has seriously delayed the launch of the Nascom 2, so we have decided to relaunch the product with an offer few will be able to refuse.

The Nascom 2 will be supplied without the optional user 4118s. Instead, we will supply a 16K dynamic RAM board and the interconnect for the NASBUS – absolutely FREE. This board allows further expansion to 32K. Also, when the 4118s become available, customers taking advantage of this offer can have the 8K for just £80 (plus VAT).

Meanwhile, the empty sockets on the Nascom 2 can be filled with 2708 EPROMs allowing dedicated usage, now with 16, or 32K of extra RAM. All the other features of the Nascom 2 are available and these include:

MICROPROCESSOR

Z80A 8 bit CPU which will run at 4MHz but is selectable between 2/4 MHz.

HARDWARE

12" x 8" PCB through hole plated, masked and screen printed. All bus lines are fully buffered on-board. PSU: +12v, +5v, -12v, -5v.

MEMORY

- 2K Monitor-NAS SYS 1 (2K ROM) ● 1K Workspace/User RAM
- 1K Video RAM ● 8K Microsoft BASIC (MK 36000 ROM)

INTERFACES

New 57-key Licon solid state keyboard

Monitor/domestic TV

On-board UART provides serial handling for Kansas City cassette interface (300/1200 baud) or the RS232/20mA teletype interface.

Totally uncommitted PIO giving 16 programmable I/O lines.

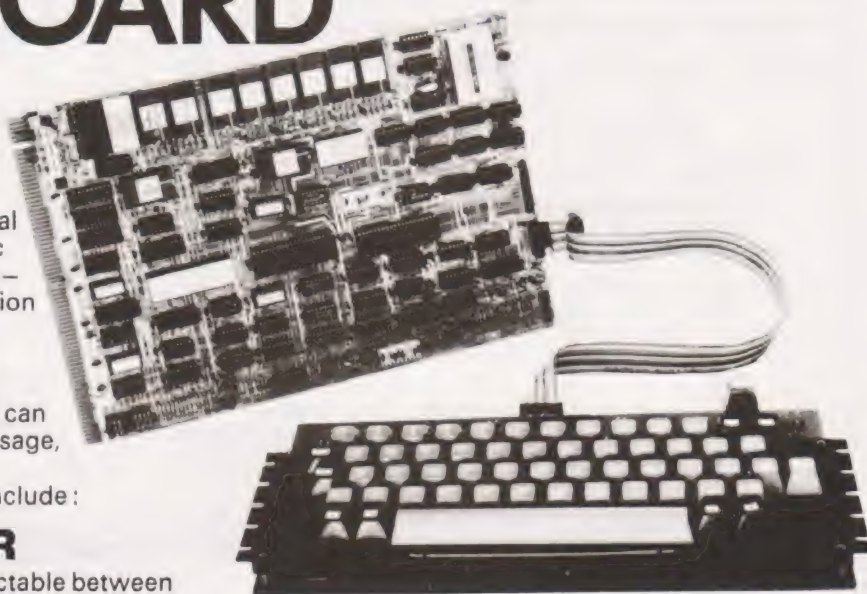
The Nascom 2 makes extensive use of ROMs for on-board decoding. This reduces the chip count and allows easy changes for specialised industrial use of the board. On-board link options allow reset control to be reassigned to an address other than zero.

The 1K video RAM drives a 2K ROM character generator providing the standard ASCII characters with additions – 128 characters in all. There is also a socket for an optional graphics ROM on-board.

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NM/CT/1

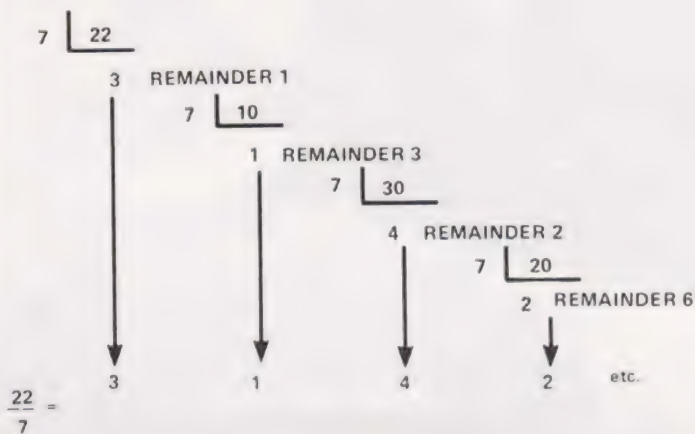
Please send me *Nascom 2 kits*
(complete with construction article and
extensive software manual for the monitor and
BASIC) at £295 plus VAT plus £1.50 p&p.
And 3A PSUs at £29.50 plus VAT
plus £1.00 p&p. And optional
graphics ROMs at £15.00 plus VAT.

NAME _____

ADDRESS _____

ACCESS/
BARCLAYCARD NO _____

Example:— Suppose we divide 22 by 7,



As the printout (Figure 1) shows, $22/7$ is a fair approximation to π . Can you find a better one?

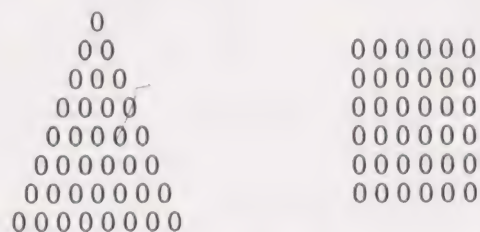
Our Solution

The program listing (Figure 2) and flowchart (Figure 3) give full details of the method. When implemented in Tiny or Integer BASIC the INT function is not required, but obviously the numerator and denominator are then limited to integer values.

All real values will ultimately produce a recurring sequence and this normally occurs quickly, as for $22/7$, but this is not always the case as $1001/997$ shows. Of particular interest is the quotient of 99991 divided by 99989 — if you find the point at which this begins to repeat itself, please let me know.

Square Triangles?

The triangle for a full-sized snooker table holds 15 red balls. If the triangle were a little smaller only 10 red balls would fit, if it were a little larger 21 red balls would go in it. However, for none of these numbers would the balls exactly fill a square frame — 36 balls will do both.



What is the next number of balls which will have the property of fitting both a triangular and a square frame? Write a program to find all such numbers less than 1,000,000. N.B. Before trying to solve problem 3, run this program on your computer.

```
10 PRINT SQR( 400) - 20
20 PRINT SQR( 900) - 30
30 PRINT SQR(2500) - 50
40 END
```

The program should print 3 zeros, if it does not, be careful!

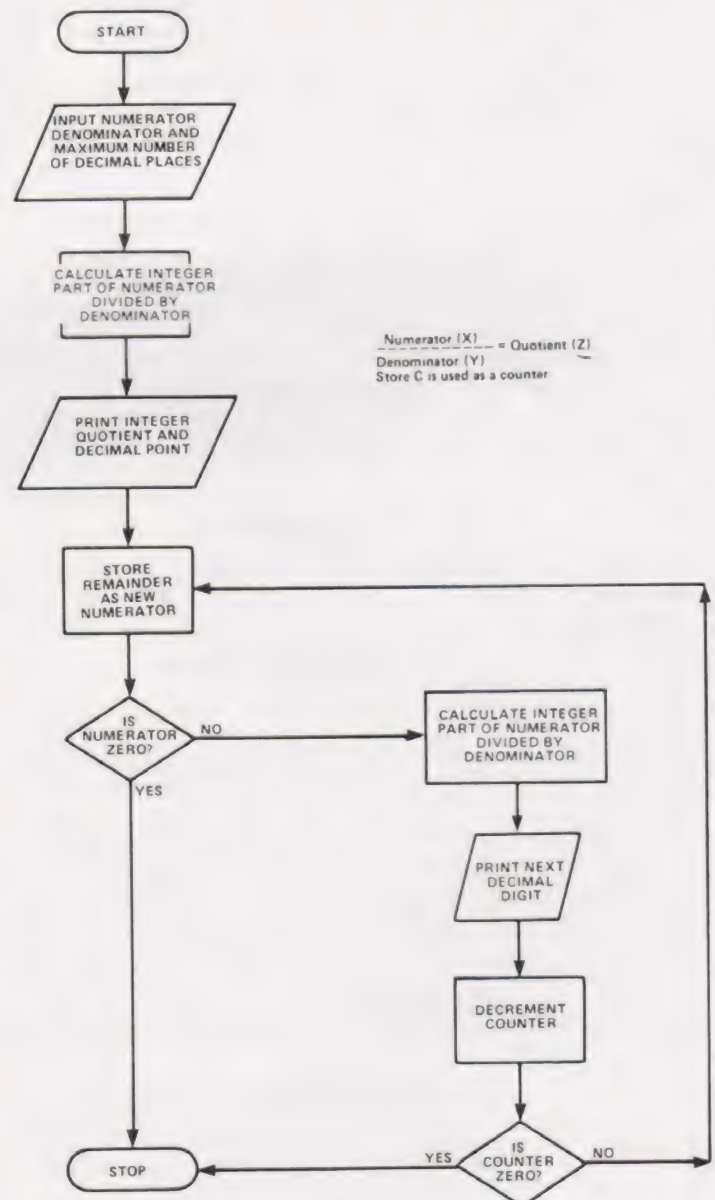


Fig.3. Flowchart for the program.

PROBLEM PAGE

DIVISION-UNLTD.

FIRST NUMBER 1001

SECOND NUMBER 997

HOW MANY DECIMAL PLACES 100

```

1 0 0 4 0 1 2 0 3 6 1 0 8 3 2 4 9 7 4 9 2
4 7 7 4 3 2 2 9 6 8 9 0 6 7 2 0 1 6 0 4
8 1 4 4 4 3 3 2 9 9 8 9 9 6 9 9 0 9 7 2
9 1 8 7 5 6 2 6 8 8 0 6 4 1 9 2 5 7 7 7
3 3 1 9 9 5 9 8 7 9 6 3 8 9 1 6 7 5 0 2
    
```

DIVISION-UNLTD.

FIRST NUMBER 22

SECOND NUMBER 7

HOW MANY DECIMAL PLACES 20

```

3 1 4 2 8 5 7 1 4 2 8 5 7 1 4 2 8 5 7 1 4
    
```

Fig.1. Sample printout from the program.

```

10 REM *****
20 REM *
30 REM * PROGRAM --- DIVISION-UNLTD. *
40 REM *
50 REM * PROGRAMMED IN 'PET' BASIC *
60 REM *
70 REM * TREVOR L LUSTY 11/8/79. *
80 REM *
90 REM *****
1000 PRINT
1010 PRINT "FIRST NUMBER ";
1020 INPUT X
1030 PRINT "SECOND NUMBER ";
1040 INPUT Y
1050 PRINT "HOW MANY DECIMAL PLACES ";
1060 INPUT C
1070 PRINT
2000 REM ***** CALCULATE INTEGER PART OF DIVISION *****
2010 LET Z=INT(X/Y)
2020 REM ***** PRINT INTEGER PART AND DECIMAL POINT *****
2030 PRINT Z;".";
2040 REM ***** CALCULATE REMAINDER *****
2050 LET X=10*(X-Z*Y)
2060 REM ***** STOP --- IF THE REMAINDER IS ZERO *****
2070 IF X=0 THEN 2170
2080 REM ***** CALCULATE NEXT DECIMAL DIGIT *****
2090 LET Z=INT(X/Y)
2100 REM ***** PRINT NEXT DECIMAL DIGIT *****
2110 PRINT Z;
2120 REM ***** SUBTRACT ONE FROM THE COUNTER *****
2130 LET C=C-1
2140 REM ***** HAVE WE FINISHED ? *****
2150 IF C>0 THEN 2050
2160 REM ***** LINE-FEED *****
2170 PRINT
2180 REM ***** STOP *****
2190 END
    
```

Fig.2. Program listing for the Division Unlimited program.

COMPUTERMANIA

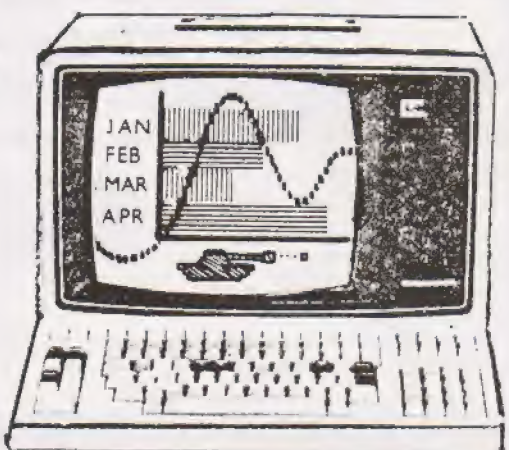
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PET IMPRESSIONS

Mr A.P. Stephenson

One of our regular contributors presents a close look at the PET from the owner's point of view

I have recently bought a PET. This is of course a classical understatement because people just don't go out and buy a PET; they read about it, compare it with other makes, rearrange finances and above all, think of a good excuse for justifying its purchase. Reading the glossy sales literature on PETS, APPLES, TRS 80's, etc. etc., the impression is gained that a home without a computer is no home at all, branding the occupant as an unfortunate member of the underprivileged classes deserving of state aid.

Justification, The Name Of The Game

It is unfortunate that the writers of these brochures place so much emphasis on the delights of game playing at the keyboard. There is nothing wrong in using a highly sophisticated system to play noughts and cross, neither is it wrong to use a Rolls Royce for delivering bags of coal. It does seem to the writer (who it must be admitted is old and inclined to be a trifle crusty) that there is something grotesque in such practices, amounting to almost a deliberate act of discourtesy to the design team responsible for the birth of the computer. There is also a practical economic reason why such emphasis could become a double edged weapon by reducing the sales potential. The manufacturers should realise that the purchase of a home computer could mean the postponement of a new lounge suite or abandoning the prospect of a couple of weeks in Majorca. Although I am fortunate in having an understanding wife it is highly probable that the domestic harmony in many households could be endangered if it was a case of new furniture or the PET, particularly if the reasons given centred around the ability of the contraption to play Star Trek or Moon Landings.

A computer can do many things, in fact anything you know how to tell it to do! As far as family life is concerned however, its role as a teaching machine offers the greatest return for the capital invested. Teachers (the normal human variety) must surely realise there are areas in any syllabus where their services are not strictly necessary. They are needed to guide, to place concepts in correct perspective and to explain difficult points which may arise but when it comes to teaching mere facts they are more expensive and less efficient than a computer. Assuming literacy, no student needs the presence of a teacher in the classroom to learn the names of the rivers in a given country or to learn the atomic numbers of the chemical elements or the dates of the English and French kings or the SI system of physical units. Not only is the teacher superfluous but the students are often bored

with the monotony and inwardly praying for the bell to ring. On the other hand, a computer which presents questions and asks for the answers from the keyboard is in many respects superior to a teacher, particularly if it finally gives the score, the time taken and a few words of encouragement at the end.

Such programs are easy to write and will have the same outline format, irrespective of the actual subject matter which can be simply a data pair list at the end which can be "READ". All children under the age of sixty enjoy learning (or rather pitting their wits) at the keyboard. There is no one to nag, no one is looking over your shoulder, no one is impatient for the answer . . . in fact the psychological environment is nearly ideal. I recently wrote a simple program to test knowledge of foreign currency. Apart from the Franc, the Dollar and the Mark, my previous knowledge was virtually nil. After a few fascinating hours at the keyboard, I can now smugly remark that the Albanians use the Lek which can be quite an impressive conversation piece if fired during an opportune moment. So, my advice to the home computer salesman is to tone down the noughts and crosses and emphasise the teaching capabilities if they want to compete with the dining room suite.

Having pontificated at some length it is time to return to the actual PET. Some reviewers have complained of the long delivery time but in my case such criticism did not apply. The order was placed by telephone at 2.15 pm and it was delivered to the door and installed by 6.30 the same evening. It is fair to point out that the firm MICRODIGITAL of Brunswick St, Liverpool is only a few miles across the water but this in itself is not an explanation because previous telephone calls to other firms in the same area were received with indifference and vague remarks like "difficult to get hold of you know". Good service deserves praise and MICRODIGITAL as far as I am concerned certainly deserve some.

Impressions

The first impression on switching on the PET is the truly remarkable clarity and sharpness of the displayed characters, almost as if they are painted by a laser beam and without a trace of jitter. The second impression is a feeling of irritation with Commodore for giving a misleading impression that the user has an "8K memory" to play with. The first message from the PET which is displayed a few seconds after switch-on is "7167 BYTES FREE" which by elementary arithmetic is only slightly less than 7K. The explanation of course is that the operating system in ROM needs some breathing space to work in; this it conveniently swipes from the 8K RAM which ethically should belong exclusively to the user. The irritation is only temporary however because a second glance at the crisp display soothes it away: a kind of video balm. Due to a lifelong interest in electronics hardware my first job was to investigate the innards by removing four large





screws on the base and folding back the hinged cover to expose the logic. It was reassuring to discover that everything that should be unpluggable is. The keyboard, the cassette recorder, the video umbilical cord, the power supply and most important of all, the major multipin IC's are all movable without the intervention of the cursed soldering iron. The mains transformer appears to be quite respectable in terms of sheer bulk and a glance at the specification markings plus a quick, and hopefully correct, calculation indicates that one could safely pinch about an amp from it without initiating a thermal chain reaction. The voltage regulators on the other hand do run a little warm so any thought of utilising the spare amp direct from them should be rejected. There are only two PC boards. One, in the lower compartment handles the entire computer logic and the RAM/ROM support with edge connectors for the external ports projecting through to the outside world. The other board caters for the various analogue demands of the CRT display. The general impression is one of sound engineering which has been influenced by the desire for high reliability and ease of access. In fact the latter quality is strikingly evident because of the large lumps of empty space which could quite easily house another large PCB without severe cramming. It must be a disturbing, almost frightening, experience for a traditional computer engineer used to minis or mainframes to believe that so much computing power lies inside such a demure little box.

This brings us to the well-discussed question of the PET keyboard . . . the "computer style" (not the "Type-writer Style" used on the 16K varieties). As far as the touch typist is concerned there is no doubt that the keyboard is a shocker. The keys are spaced only two thirds the normal "standard" and although the QWERTY layout is preserved the conventional staggering isn't. So much for the touch

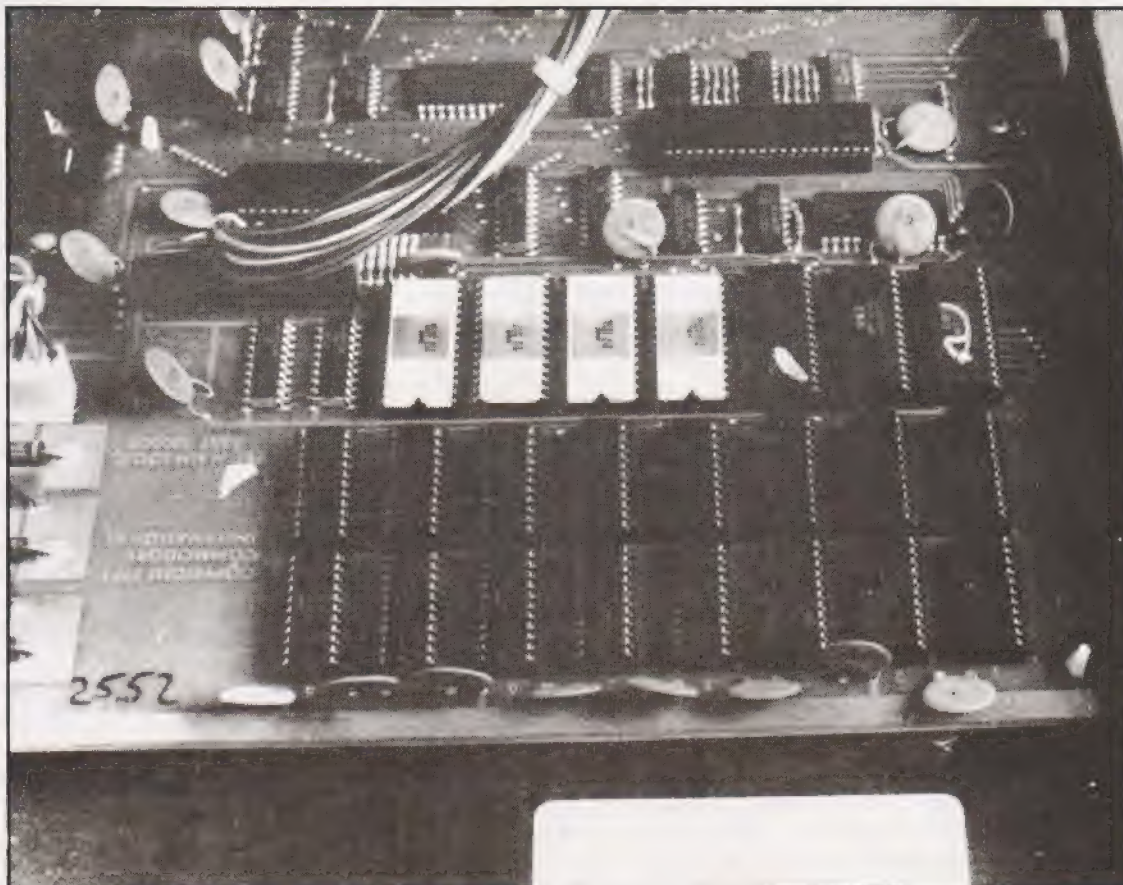
typist's view. But how many of us are touch typists? And how many would ever really take the trouble to learn it . . . in spite of the oft-quoted advice that it is easy. My own prowess on a normal typewriter is somewhere in between the "one-fingered-prodder" and the skilled touch typist, in fact a typical amateur keyboard basher who has to *look* at the keyboard before striking. Now it may be that my metacarpals are abnormal but the strange fact is that I can use the PET keyboard *faster* than my typewriter! Dare I suggest that the particular spacing of the conventional keyboard came about by accident without the assistance of ergonomic principles? It may be that the professional touch typist only thinks the typewriter layout is perfect because she or he has never been trained on anything else. For example, there is no doubt that the piano keyboard spacing was indeed a mistake in the beginning. The most beautiful interval on the musical scale is the tenth and yet very few performers can stretch it because the keys are just a shade too far apart for comfort. But this subject is of course sheer heresy and could lead to an avalanche of abuse from the "establishment". In any case it appears to me that the actual entering of a program (or data) occupies a relatively minor proportion of the time spent on computing exercises; it probably takes twenty times longer to write the program than to enter it afterwards. In view of this, I believe that the criticism of the PET computer-style keyboard is a little harsh and unjustified, as far as the computer hobbyist is concerned.

Taping The Problem?

Another much discussed question is the PET cassette recorder which apparently caused a good deal of frustration at one time. There are two kinds of PETs, the so called "early PETs" and the others. I don't know at the moment whether my species is early or not-early since the chronological details

PET IMPRESSIONS

Two of the much maligned areas of the PET. The original keytops wear out, Commodore have sent us a replacement set, and the keyboard spacing and layout would make a touch typist shriek. The cassette unit has been much improved but still needs regular cleaning and de-magnetizing.



The memory areas of PET are well laid out. The first two rows are the RAM chips, with the lower end on the right. Behind are the BASIC and monitor ROMs. All are socketed for easy replacement should anything die on you.

of the transition point remain misty. Perhaps I am lucky because LOAD and SAVE have never yet resulted in the dreaded message "LOAD ERROR" on my machine. When it came to inputting long streams of DATA (rather than programs) I was not so lucky because there is no doubt that the blocks are either written too close or conversely, the tape motor speed is wrong because the programs frequently crash causing funny little groups of colons to be painted at random screen positions. However, study of one of the Workbooks ("PET CASSETTE No 4") published by TIS points out that this tendency is due to some sort of software "mistake" in the part of the operating system ROM which handles the INPUT and PRINT#1 commands. Apparently the reliability is improved if the cassette motor is switched on for 0.2 seconds in between blocks and they publish a simple sub-routine which handles the problem. Perhaps Commodore may feel they are ethically (if not legally) obliged to replace the ROM. After all, if the statement advertised as PRINT#1 frequently prints colons instead of the required data and crashes, then PRINT#1 should be "repaired". After all, they have already swiped about 1K of our memory, so they have no right to expect us to waste another block of precious RAM to rectify an inherent fault in the operating system. Perhaps Commodore may like to comment on these points?

Manual Discourse

The next grumble is directed at the so-called "PET USERS MANUAL" supplied with the machine. Considering the intention is to instruct the first-time user of a "home" computer in the mysteries of a new art, it fails miserably. Frankly, it is an atrocious document, unworthy of the brilliant piece of engineering it purports to explain. It gives the impression that it was written by an expert who was slightly bored and annoyed he was given the job of explaining it to

the common proletariat. It alternates between unnecessary detail and condescending triviality. It was obviously never proof read because there are numerous errors. I wonder if Commodore (or indeed many other manufacturers in the home computing field) realise how damaging are the effects of a slovenly written manual. The advertising campaign indicates that sales are expected from the ranks of the "small businessman". It must be an entertaining sight to watch the face of one of them as he plugs in his PET, and opens the manual expecting to "dash" off a program which will handle all his VAT and other accounting chores. An article appeared recently in a well known trade journal which illustrates the kind of cloud cuckoo land that some people inhabit. Apparently "...most businessmen have the initiative and common sense to master a small computer in an hour or so...". Assuming such naive faith to be justified one would certainly need a little more than initiative and common sense to battle through the Manual. The alternative is of course to forget programming and buy the software on tape. But here lies another false idea because there is no such thing as *general purpose* software and however much a businessman spends on tapes there will almost inevitably be an awkward twist which is peculiar to his own system. This will require some "slight modification" to the software, which is normally where the real trouble starts. It would be a good idea if the present manual was withdrawn and replaced by a simple account of the principles of computing, a short glossary of terms, and clear, repeat clear, instructions on how to operate the machine. There should also be a straightforward list of the BASIC statements and commands printed on a pull-out card. The teaching of the BASIC language should be left to either a list of recommended books or perhaps the profits could stretch to the inclusion of one free with the machine.

The Language It Talks

The version of BASIC used on the PET is excellent. Pity they couldn't have included the MAT functions but perhaps a plug-in ROM with these and a few more functions may turn up one day. One useful feature is the abolition of the word LET before every assignment statement. It is pleasant to be able to use it or ignore it at will. Another useful time-saving aid is the ability to use "?" instead of laboriously typing out the word PRINT every time. One rather peculiar function included is "POS" which simply tells you where the cursor is! Can't for the life of me fathom out why you would need to know where the cursor is because you can see the thing . . . but perhaps this is just a failure to grasp its hidden power. No hint of course from the manual . . . but I mustn't start again on that.

An illustration of the foresight of Commodore is the provision of, what is almost certain to become an industry standard, the IEEE-488 general purpose BUS. There have been some discussions on the relative merits of this bus and a "rival" system called the S100 BUS. This argument seems pointless because the two systems are not intended to be in competition. The IEEE-488 BUS is intended to handle peripherals, in fact a maximum of fifteen at one time can be handled. The S100 on the other hand is a MEMORY bus and belongs properly to the mini, rather than the microcomputer environment. It may be some time before PET users will have the courage and acquire the necessary knowhow to exploit the full potential of the IEEE-488 BUS but it will certainly repay future study (after the initial novelty of the PET has been replaced by a desire to make it earn its keep). The USER PORT however is easy to use and providing you have some elementary electronic knowledge, particularly in the field of TTL logic, it should enable the machine to control some very interesting external systems . . . model railways etc. It would be a pity to underuse the full potential of the PET by restricting its working life to number crunching and table printing. One little word of warning may be issued at this point. Always use some form of buffer gate between any of the port pins and the external system, preferably optoisolators. The conversion of analogue to digital (or vice versa) is accomplished quite cheaply by a couple of Ferranti ZN425E chips and the supporting software should not prove difficult.

Machine Code Lack Disappoints

One disappointment to me was the absence of a machine code monitor; perhaps a full blooded assembler would be asking too much. No doubt these are available on tape but it would have been nice to have found it was already in ROM. There will be several times during program development when the inherent slowness of a BASIC interpreter will cause frustration. It is during such times when the user would be willing to sacrifice the simplicity of a high-level language for the lightning speed of a machine orientated conversation, perhaps a thousand times faster in some cases. Facilities exist already for leaving the shelter of BASIC and nipping into the hard logic world of the machine via the help of the User Subroutine function (USR) but without the help of a monitor it appears to be a tricky kind of operation, this may be due to lack of experience.

The microprocessor used in the PET is a 6502 which is a kind of 'tarted-up' version of the 6800. The single index register has been split into two called the "X" and the "Y" registers and two new addressing modes have been included, pre-indexed and post-indexed. Unfortunately, the second accumulator has been sacrificed in the process which may be considered by some a rather severe restriction.

Display Yourself

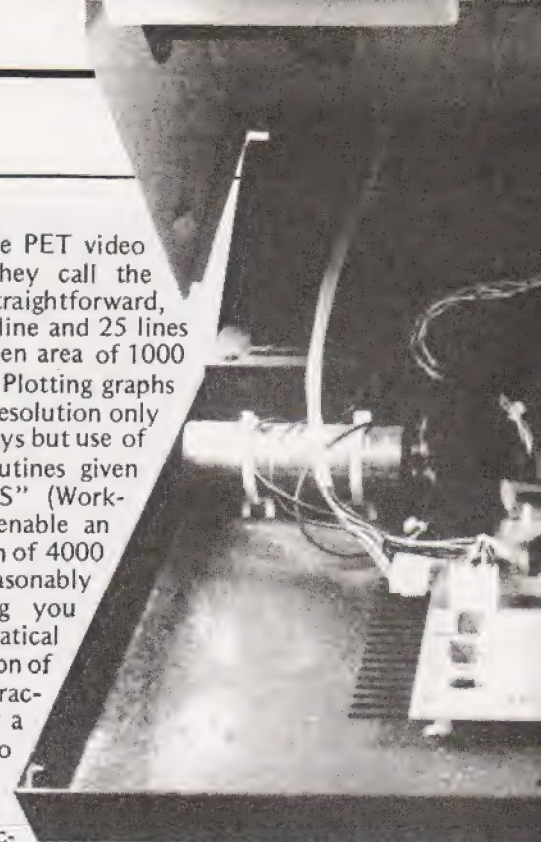
The layout of the PET video display (which they call the "TV" display) is straightforward, 40 characters per line and 25 lines giving a total screen area of 1000 printing positions. Plotting graphs on such a limited resolution only yields crude displays but use of some ingenious routines given in the "GRAPHICS" (Workbook 3) by TIS enable an effective resolution of 4000 points which is reasonably tolerable providing you are not a mathematical pundit. The position of the next print character is signalled by a winking cursor, to my mind it winks a little too brightly and is rather distract-

ing; a winking asterisk or full stop would have been adequate. Another example of Commodore's foresight is the inherent provision of an 80 column line which is more standard for commercial printers. Thus, although the video line is only 40 characters, the program memory will allow 80 characters. The ability to display in reverse lighting is very useful for italic text although it is possible to get into some weird fixes until the procedure becomes second nature. To clear the screen under program control we are told to use the "reverse heart" but it is so easy to forget to cancel the "reverse" afterwards that I have decided to use ?CHR\$(147) which is a bit longer but less error prone. The special graphics characters are all that Commodore says they are and have been very carefully chosen to enable the most impressive artwork to appear on the display. It does take a lot of practice however before the keys can be controlled to act as a doodling pencil. It is a pity there is no provision for locking the SHIFT key because it would avoid the feeling of strained tendons which could result from an attempt to keep it depressed simultaneously with a character.

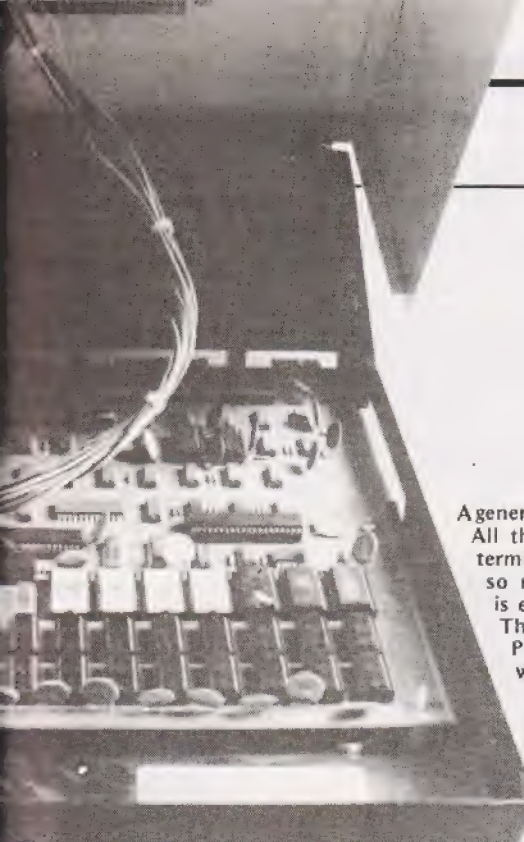
Lower case characters can be obtained by POKE 59468,14 but they function as if they were upper case because you have to push the shift key to obtain them. I often wonder why, bearing in mind so many people will use the PET for maths and physics, that Commodore did not include the Greek alphabet set as a pokeable function; but then, as far as I know, no other home computer has this facility.

Expansion For Me

Having spent several hundred pounds on a PET the thought of spending any more fills the mind with horror but nevertheless there will be a nagging desire to own one or two of the fascinating "extras" . . . similar to the hi-fi addict's complex. The greatest dream is probably the floppy disk because the ability to have about half a megabyte of backing store capable of delivering the wanted file in about a thousandth of the time it takes the lowly cassette to oblige is almost as fascinating as the tales from the Arabian Nights. Unfortunately they are expensive gadgets even if a single disk drive is considered satisfactory. But there are many reasons why a double disk is virtually an essential. The floppies themselves are prone to wear because they rotate inside their cover and important data should be periodically copied onto



PET IMPRESSIONS



A general internal view of the PET. All the umbilical cables are terminated in plug/sockets so removal of any section is easily accomplished. The various ports are PCB edge connectors which feed out through slots in the case. The case has a strut built in, which holds the machine open as shown, fitted on the left hand side, a very useful addition.

a fresh disk. A single disk drive is at a disadvantage here and a full copy protect via the RAM in small instalments is a lengthy project.

The official PET printer is about £800 which, although probably worth it in terms of spec, is certainly out of reach of many people's pockets. Perhaps it is a trifle over-spec. for the mass market and Commodore might like to consider the production of a cheaper model, with a less

sophisticated function repertoire? The first thing I will buy (if of course the Editor accepts this article!) is a second cassette recorder, perhaps the most valuable addition to a PET which doesn't place unnecessary strain on the finances, and makes data file copying a simple exercise. The C2N is obtainable at the VAT inclusive price of about £60 and plugs straight into the PET without any interfacing or extra software support problems.

Software = Laziness?

There is an enormous library of software available for the PET. In some ways, this is a pity because it will tend to influence the new owner to become lazy, turning him or her into a "cassette parrot". There should be an act of parliament forbidding anyone who has bought a PET from purchase of program tapes for a period of one year from the date of owning it! In this way, the owner will have had some time to learn BASIC thoroughly and to have built up a degree of independence and develop a critical attitude to commercial software. At the risk of offending some of the software houses, the price charged for some of their work is downright robbery. To be tied to other peoples programs all the time is waste of the creative potential of the PET. It is far better and yields far more satisfaction to write your own program, even if it does take a few more bytes and uses a few ugly twists which draw tut tuts from the professionals.

Some of my colleagues can't understand why someone like myself, who teaches programming and computers for a living, should want to actually BUY a computer. Sometimes I wonder myself. One thing I can say... I don't regret it and very few people who do buy them will.

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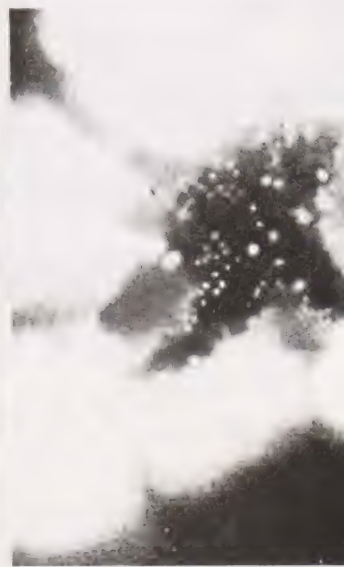
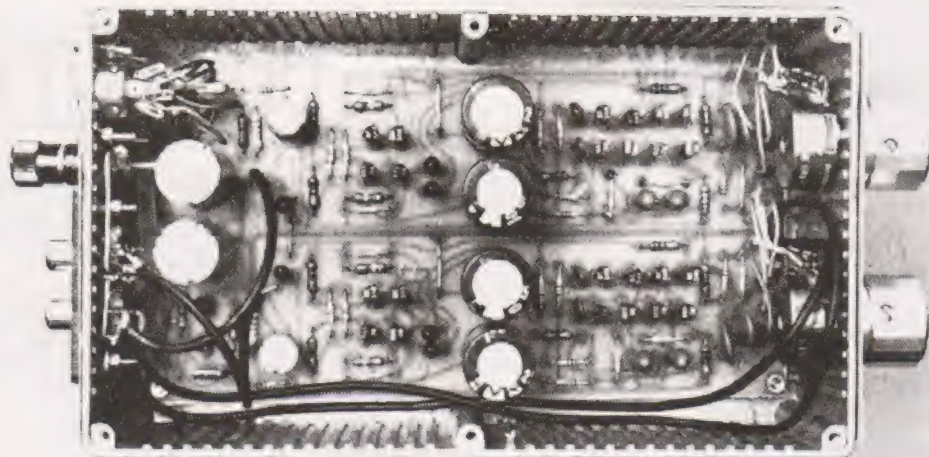


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				74157	—	.40					
				74160	98	.57					
				74161	—	.56					
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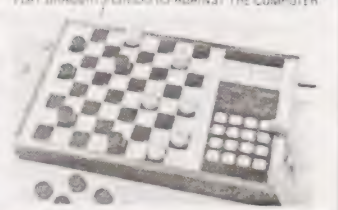
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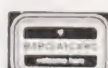
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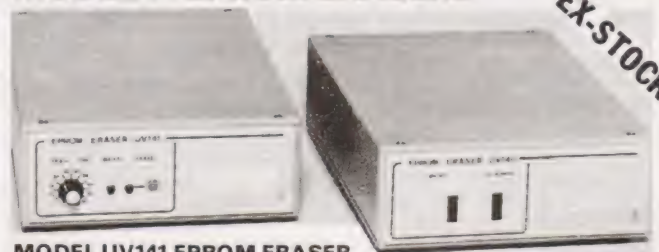
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SPEECH SYNTHESIS

A talking, talking point or two?

Speech and language have been the natural way of communicating information for thousands of years and writing, particularly in its new form of computer data, is a comparative newcomer. This results in an interface problem between men and machines. A computer finds it easy to output written data on a VDU screen and to accept data from an ASCII keyboard, but to 'speak' the results and to 'listen' for instructions is enormously more complex. This would, however, be an ideal situation because the computer would literally talk your language. It would also be far more efficient because you can listen at a faster rate than you can read and you can talk at a faster rate than you can type. Also, this natural interface releases the operator from the VDU screen or keyboard, enabling them to perform other tasks. There are several machines presently available that can talk and listen, but before discussing them it would be useful to describe how natural speech is produced.

The Vocal Tract

The vocal tract (Fig.1) is an air-powered sound generating system. When we expel air from the lungs it has to pass around the vocal cords. These are a pair of muscular tissues which may be voluntarily tensioned. When they are so, the airflow causes them to buzz, (just like a reed in a reed instrument), the pitch of the buzz is then acoustically filtered by the rest of the vocal tract, which has some very complex patterns, (Fig.2). In fact the vocal tract looks like a multi-peaked acoustic resonator. The peaks are known as formants and they change position as the tongue hump and lips move to form different sounds. This process is known as mouthing or articulation. This dynamic filtering that changes the vocal cord buzz into speech. Some typical formant frequencies for steady state vowels are given in Fig.3.

If speech were merely composed of a few steady state vowels it would be quite simple to synthesise. It isn't, there are many other phonetic elements. Take for example the word HOW. This has two sections, an aspirated H and then the OW sound which is a vowel glide from the AW vowel (as in down), to the OO vowel (as in too). The vowel glide is known as a diphthong and is generated by rapidly altering the shape of the vocal tract. Some other diphthongs are :- BAY, BUY, BOY and HOE. The aspirated H sound is produced by blowing air through the vocal tract whilst mouthing the ER vowel as in BIRD. Note that the vocal cords are not producing a buzz, the sound is made by filtering noise. This type of sound is known as unvoiced; voiced sounds being produced by the vocal cords. Another type of unvoiced sound is

the fricative, the 'S' sounds. These are produced by blowing air inbetween the teeth and lips. For example the following word has several fricatives, 'TWELFTHS'.

Nasals are yet another type of phoneme generated by closing the mouth and allowing the sound to exit via the nasal cavity. The last type of sound to be considered is the stop consonant, (a plosive), which is characterised by a sudden opening of the mouth. This produces a period of silence, (a stop), and then as the mouth opens the formants rapidly move towards their target positions. For example, the stop consonant GA starts with a rapid opening of the mouth, the formants moving quickly to take up the position of the AH vowel. If a short noise burst is introduced at the start the phoneme becomes KA instead of GA. A table of phonemes is given in Fig.4. Using this list it is possible to phonetically spell words and phrases, the spelling actually describing the sound structure of the words.

Pitch is often used in speech to impart some information. If a particular word in a sentence needs to be emphasised then the pitch might rise until it reaches that point and then fall, thus stressing that word. Other stress mechanisms are volume and timing.

This brief description of speech generation shows how complex the system is. Machines that talk will also have to perform the same complex tasks.

Electronic Speech Production

There are many ways to generate speech electronically. It could simply be converted into a digital code (Fig.5), which could be recalled from a memory when required. This method produces high quality speech, but uses up very large amounts of memory. The speech produced has the same accent and inflection of the original speaker

and new speech can simply be entered by a repeat recording. It is possible to store the speech as a series of disconnected words and phrases which can be recalled and reassembled into a variety of phrases. There is a commercial data entry system that operates on this principle, (Fig.6). This is a stock ordering/availability system for garages. Each user has a data entry keyboard/loudspeaker terminal that connects into the telephone system. When a user wants to order a seat belt say, they phone up the distributor and then type in the part number of the component that they require. A series of 2 tone signals are sent down the telephone line, which are decoded at the other end and the data is sent to the computer stock control. This looks at its memory to see the price and delivery for the part and then selects stored words from a drum storage unit. These words are then strung together to form a sentence which is then spoken to the user at the other end of the system.

Note that the user has to use a keyboard to input information and the speech storage unit has to be a drum because of the vast amounts of data required. Most of the

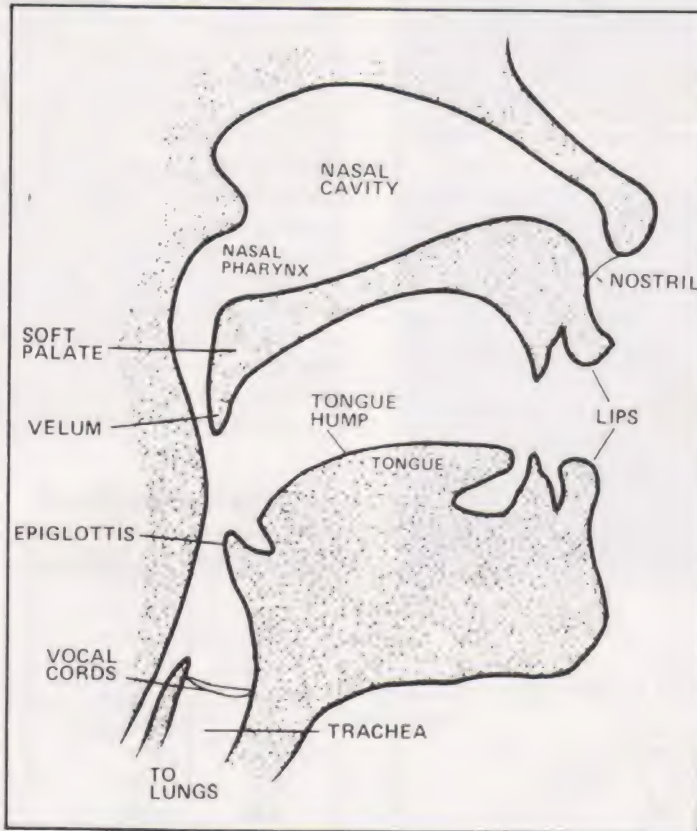
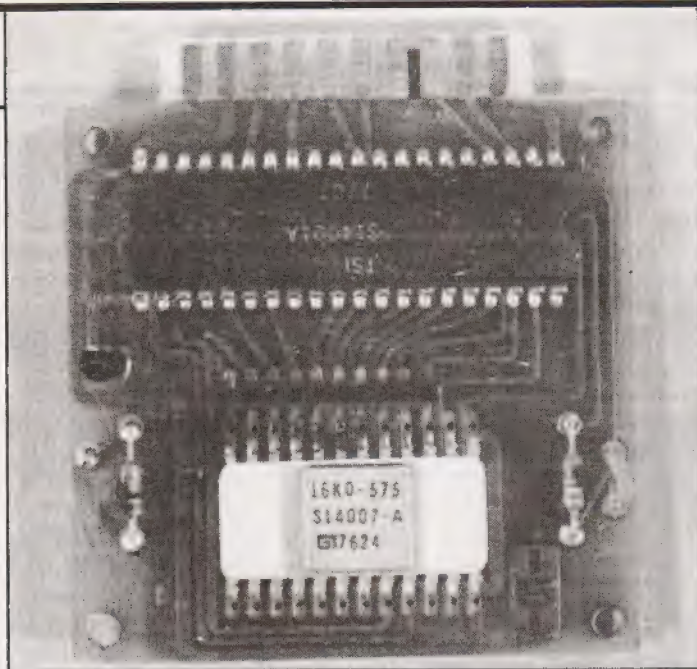
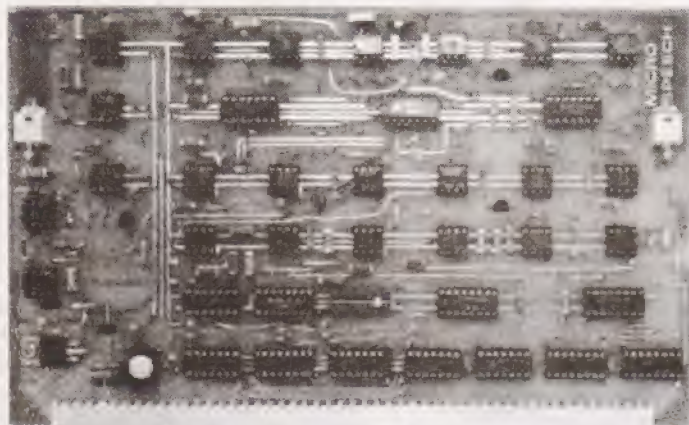


Fig.1. The human vocal tract.



Telesensory systems speech generation unit. Available as either a 24 word calculator vocabulary or two 64 word general purpose vocabularies. The speech is in ROM.



The Microspeech synthesiser.

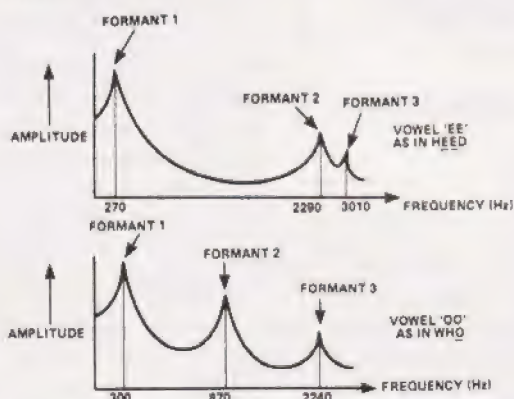


Fig.2. The output spectrum for two vowels. Spectrum is equal to the frequency response of the vocal tract times the excitation waveform.

EXAMPLE	VOWEL	FORMANT FREQUENCY		
		F1	F2	F3
HEED	EE	270	2290	3010
HID	I	390	1990	2550
HAD	AE	660	1720	2410
PAW	AW	570	840	2410
WHO	OO	300	870	2240

Fig.3. The vocal tract resonances for steady state vowels.

information in speech is redundant, there are many repeated waveforms that are not unique. It is possible to produce speech from very little data but this requires the use of a speech model. The rest of this article is a resume of speech based products on the market.

Microspeech — Synthesis By Rule

Microspeech is a speech synthesiser that generates speech from phonetic text. It is a peripheral device that plugs into the SWTP and MSI microcomputer bus. It uses a synthesis model to produce the speech, (Fig.7). An oscillator is used to simulate the vocal cords and a noise generator for the unvoiced sounds. Three voltage controlled filters are used to simulate the action of the formants and a fourth is used for the fricative sounds. By supplying the model with the correct 9 parameters, (4 for amplitude, 4 for resonant frequency, 1 for pitch), it is possible to produce synthetic speech. These parameters are generated by the software which in turn is driven by phonetic text. For example, if you wanted the computer to speak the phrase 'Well, it can do with me', the phonetic spelling would be entered 'WEHL IHT KAN DOO WIHTH MEE', (see Fig.4 for list). The programme then computes the 9 parameters which it then delivers to the synthesiser as frames of data, (8 bit resolution), every 50m Sec. This data is then converted into 9 analogue control voltages which drive the model and so generate a speech output. The amount of storage required is very low indeed, all that needs storing is the ASCII characters of the phonetic spelling. A 1K buffer can hold 90 seconds of speech. The programme is available as a speaking BASIC option.

A second version of the synthesiser will shortly

VOWELS *-DIPHTHONGS

PHONEME	EXAMPLE
* AI	BAIT
* AY	PACE
AA	BAT
AH	FATHER
* HW	DOWN
AO	BOUGHT
EH	BET
ET	THE
ER	BIRD
EE	BEAT
IH	HARMONY
IX	BIT
* IY	BUY
* OY	BOY
OO	BOOT
O	HOT
* OW	BOAT
U	BUT
UH	BOOK

SEMI VOWELS

Y	YOU
W	WHEN

LIQUIDS

R	RENT
L	LET

NASALS

PHONEME	EXAMPLE
M	MET
N	NET
NG	SING

PLOSIVES

P	PET
T	TEN
K	KIT
B	BET
D	DOG
G	GET

ASPIRATIVE

H	HAT
---	-----

FRICATIVES

F	FAT
TH	THING
S	SAT
SH	SHUT
DH	THAT
V	VAT
Z	ZOO
ZH	AZURE
CH	CHURCH
J	JAM

Fig.4. The table of phonemes.

SPEECH SYNTHESIS

become available, MICROSPEECH II, (Fig.8). This has its own dedicated microprocessor, a 6802 with the program stored in EPROM (two 2716). The machine is a stand alone device which receives its instructions as phonetic text via a standard teletype interface. The speech model uses a more complex filter structure with a male/female option. Other manual controls are pitch and speech rate. An internal amplifier/loudspeaker provides the speech output.

Speak And Spell

The Speak and Spell unit is a teaching aid to assist children with spelling. The machine asks the child to spell a series of words which have to be entered via an alphabetic keyboard. An alphabetical display provides a visual indication of the entered data in addition to the machine speaking the letters. When the word has been correctly spelt, the machine says, 'THAT IS CORRECT, NOW SPELL'. The vocabulary is about 200 words and is expandable with plug-in modules. It is possible to construct phrases from the individual letters of the alphabet, for example 'L,O,I,C,U,R,O,K!' (translation; "Hello, I see you are OK").

The hardware consists of a dedicated microprocessor (a modified TMS1000), two large 128K bit ROMs and a speech synthesiser, (Fig.9). The system is based on linear predictive co-efficients which is a method of producing speech with very high intelligibility but requiring only medium data storage, about one percent of that needed for a direct conversion method. To produce speech the microprocessor addresses the ROM and extracts the linear predictive co-efficients, which are then decoded into 12 speech synthesis parameters. Two of these parameters determine the



Speech Lab recognition hardware.

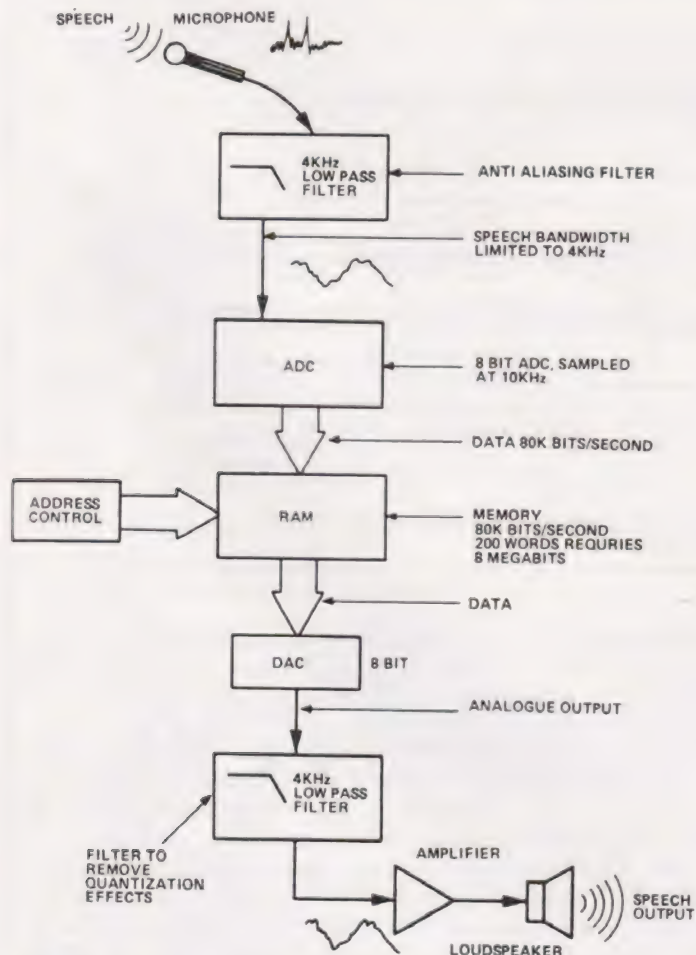


Fig.5. The electronic storage of speech.

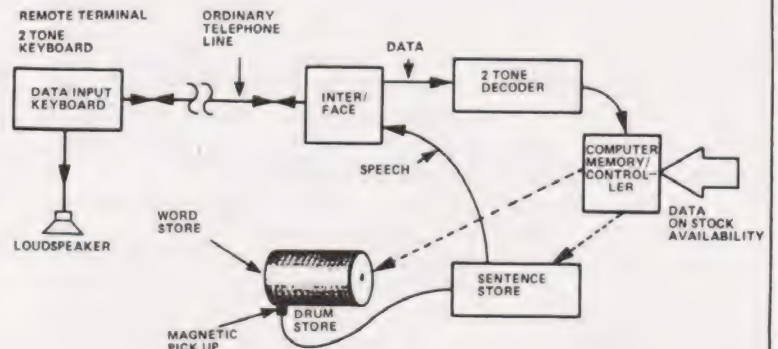


Fig.6. A typical data entry system.

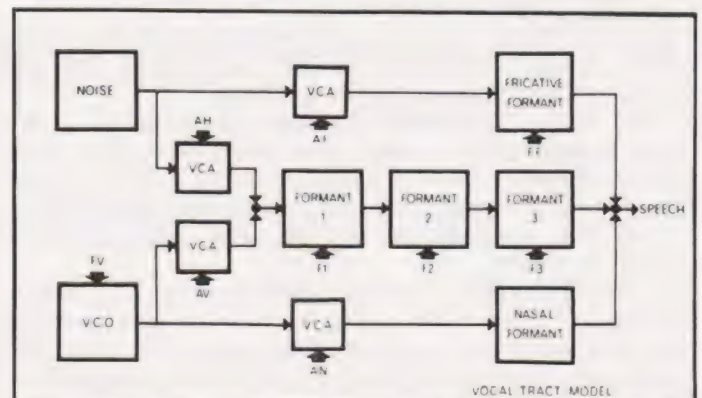


Fig.7 The Microspeech model of the vocal tract.

SPEECH SYNTHESIS

voiced/unvoiced decisions, pitch and amplitude and the other ten parameters the formant positions in the digital speech model. Data generated by this model is fed into a DAC which then drives a small loudspeaker.

The Speak and Spell chip set is not at present available, but someday perhaps it will be. This will enable the constructor to produce fixed vocabulary voice output units, probably with a considerable choice of words, (a few thousand). The new TI home computer is available with a speech output option, based on this system.

Talking Calculators

Telesensory systems make a range of products for the blind, one of which is a talking pocket calculator which speaks the results of the computation. The unit has a fixed vocabulary of words which are stored in a ROM. They also sell separately a printed circuit board containing the speech electronics, with three vocabulary options, one with 24 words, the other two with 64 words. For a small consideration they will, I believe, produce a custom vocabulary ROM.

Another blind aid from Telesensory Systems is an electronic reading device. The operator uses a handheld miniature camera to scan the printed page. The typeface is analysed, using pattern recognition techniques. The spelling of the text is then determined and is then converted into phonetic text to drive a speech synthesiser which actually 'reads' the printed text. The problems involved in performing all these processes are enormous but the company claims good results with a wide range of typeface.

Speechlab

In the film '2001 A Space Odyssey' the two astronauts had to find a soundproof enclosure so that the computer could not hear what they were saying about it, although they didn't know it could lip read. Lip-reading computers are still science-fiction, but speech analysing ones are here. Heuristics make a plug-in peripheral unit for the S100 bus. It can recognise 64 words in real time with a 95% success rate. The unit has to be trained. You speak the word TELEPHONE and type in this word. Next time you say this word the unit will recognise it and perform some 'telephone' related task, as per your program. This could be used as some sort of data entry, inventory control or speaker verification.

The unit contains some analogue filters that analyse the audio input into three frequency bands. The time varying energy levels in these bands are then used to perform effective pattern recognition of the speech input. It is important to use a vocabulary of words that have significantly dissimilar phonetic clues. Similar words like THREE and FREE may well become confused.

Some Other Products In Brief

- * **ANGLOPHONE** is software sold by Upper Case. It converts normal spelling into phonetic code suitable to drive the Votrax and Computalker speech synthesizers.
- * **THE APPLE** microprocessor has a voice output. It is a direct storage method using delta modulation. You speak into a microphone and the speech is stored on a minifloppy disc. Also at the same time you type in what you have just spoken. The computer can then recall the phrase which it outputs as speech.
- * **COMPUTALKER** is a speech synthesis by rule, plug-in peripheral, for the S100 bus. It is driven by data generated from a programme controlled by phonetic code. Two other models are available, one for the TRS-80 computer, and one for the Apple II computer.
- * **ITT** have just announced a digital speech synthesizing

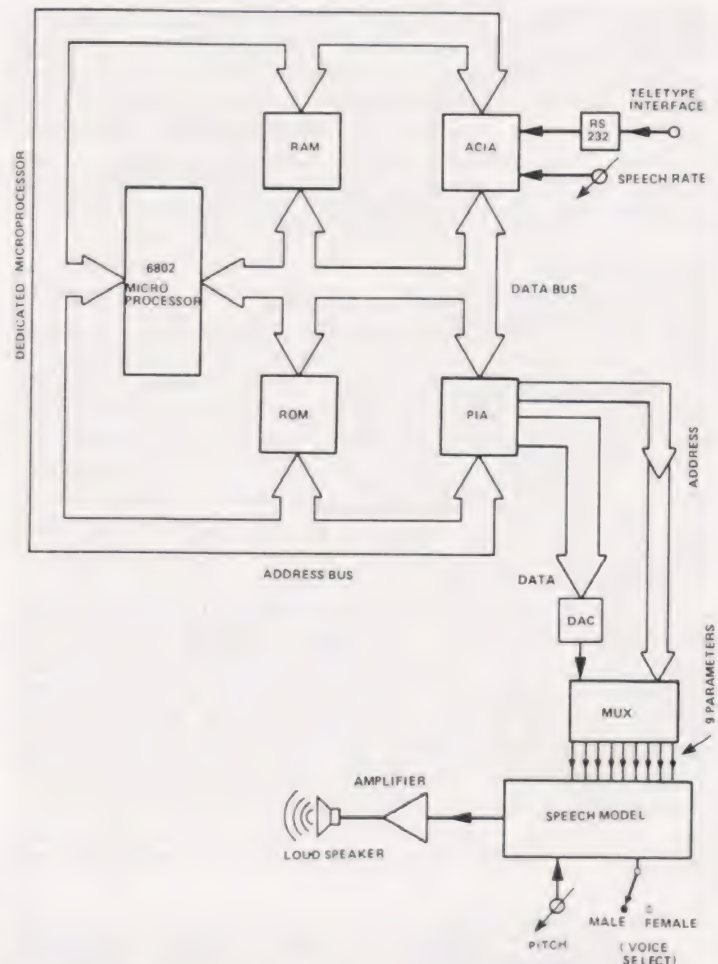


Fig.8. The block diagram of the Microspeech unit.

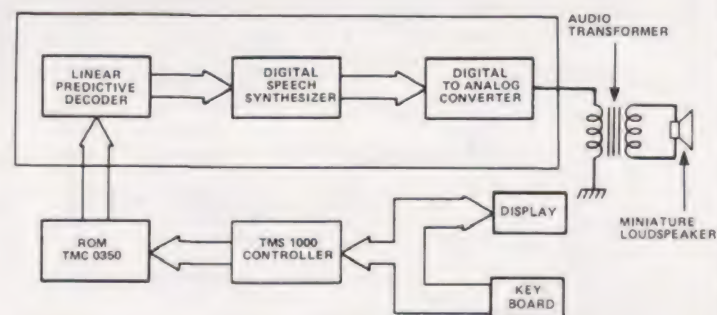


Fig.9. Speak and Spell's hardware configuration.

integrated circuit. The device stores a vocabulary of more than 20 words plus some control circuitry on a single VLSI MOS IC. Its intended use is for talking clocks and other fixed response devices.

* The Master Specialties Company produces a programmable voice readout system. The MSC Model 1700 Voice System can produce up to 16 words of high fidelity voice readout, all the hardware being on one circuit board.

* The VOTRAX company has a stand alone speech synthesizer. It is driven by phonetic text, which it converts into speech by using its own dedicated microprocessor, software and speech model. The user can manually set the speech pitch and rate.



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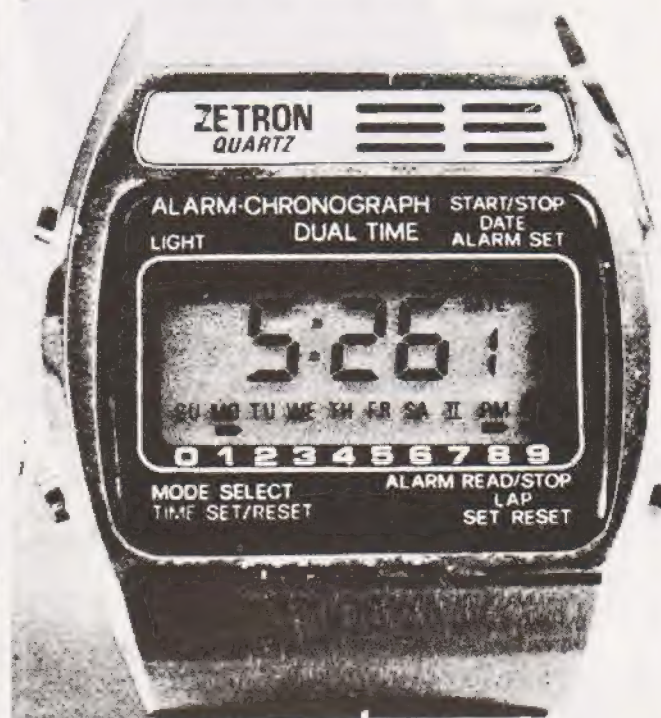
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A simple to build add-on for your Nascom, it's memory mapped don't forget!

This circuit came into being because of a desire to simulate on a Nascom some of the video games that can be found in pubs and clubs. It soon became clear that the character set (font) of the existing alphanumeric generator, whilst being useful, was not extensive enough to provide really interesting displays. In fact, graphics generation was required.

At present there seem to be two common types of graphics generator systems in use. The first type, as used in Teletext, splits each character cell into six blocks and assigns one bit of the character code to each block to determine whether it shall be white or black. This gives a low definition structure which is alright for large diagrams, but not for the sort of display required. The other type, as used in Triton etc, features a second character generator (in PROM) to give characters of equal definition to the alphanumerics. This would have been exactly what was needed, except that the character shapes would need to be defined at the time the PROM was programmed. The inflexibility this gave was unacceptable.

What was obviously required was a RAM that could be addressed by the microprocessor and filled with the appropriate font from a table at the start of each program.

Addressing

To understand how the RAM can be addressed, consider the alphanumerics generator. It can produce 128 characters so a seven bit code ($128 = 2^7$) will select a particular character block within the generator. Each character consists of 16 lines on the screen so a further four bits will inform the generator which line the VDU is currently displaying.

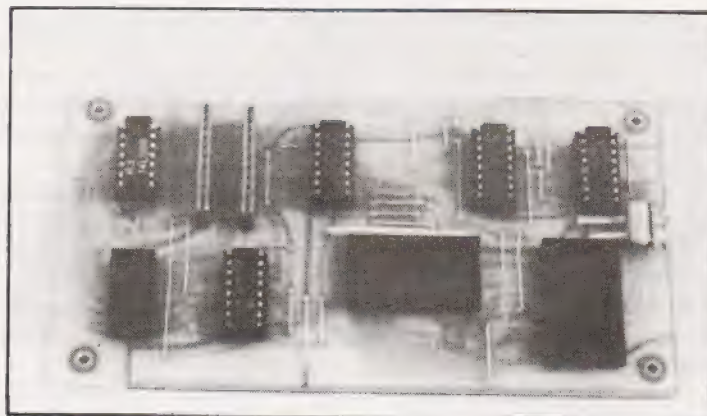
Thus, if the VDU is showing the top line of a letter 'A', the generator input will be 410 (41 = ASCII 'A', 0 = line zero of character). Similarly, the input for the bottom line of a letter 'T' would be 54F.

The output of the generator is a seven bit parallel word representing the white (1) and black (0) portions of the character line addressed. The RAM graphics generator will therefore need to be programmed with each line of each character required.

Choice Of RAM

Believe it or not, the main requirement of this circuit was that it should be useable on a minimum Nascom! Any program would therefore use less than 1K bytes. As this would have to contain the graphics font there was obviously a practical limit to the size of font that could be handled and therefore the size of RAM needed. 256 bytes was thought to be the most reasonable figure, and this would give either 16 characters of 16 lines each or 32 characters of 8 lines each. A limitation of 16 characters seemed rather restrictive so the 32 character scheme was chosen. This had the added advantage that in order to maintain the same character aspect ratio as the alphanumerics, ie. one dot horizontally to two lines vertically, the output of the RAM only required four bits. The complete generator could therefore consist of one 256×4 RAM.

Did I just say advantage? Because the video circuits can sample the RAM at any time, its outputs must be constantly enabled. However, its inputs are connected to the



The prototype PCB. The strip socket is for the RAM.

CPU data bus — it has to be programmed, remember. The use of tri-state buffers would have meant a larger circuit board, so 256×4 RAM with separate input and output pins was needed. A search of data sheets yielded one device that satisfied these criteria: the 2101. With a Z80 working at 2MHz the standard 1uS version is not really fast enough, and to be on the safe side the 650nS version, 2101-2 is used. It must be said that this family of RAMs have not previously been common on the amateur market, but hopefully some kind suppliers will start stocking them.

Wherefore Art Thou RAM

Because the alphanumeric generator only requires seven character select bits, it is possible to use the most significant bit in the VDU to select either a graphics or an alphanumeric output. This means that the graphics character codes will be in the range 80 to 9F.

The position of the RAM on the microprocessor memory map is very much up to the individual. For a minimum system the best position is 1000 to 10FF, as discussed later, but it must be remembered that it is Write Only Memory. Thus although the least significant four data bus bits can be written into the RAM, its contents cannot be inspected by the CPU.

The Nascom Connection

The design of the circuit is based on a philosophy of using a minimum of existing connectors on the Nascom for all the interconnections. Indeed, the character generator socket and the edge connector between them carry all the necessary lines except two. These are the most significant VDU data bit and one of the inputs to the video shift register (earthed on the Nascom). Luckily there are two unused pins on the character generator socket (IC16) so these can be used. (The alphanumeric generator, IC16, is of course going to be transferred to the new board). As the VDU bit must be latched there are three links to make on the Nascom board:

- 1) IC28 pin 18 to IC17 pin 18 (VDU bit 7 to latch input)
- 2) IC17 pin 19 to IC16 pin 14 (latch output to character generator)
- 3) Disconnect IC15 pin 6 from earth and connect to IC16 pin 10 (one bit of character output to video shift register)

The connections to the character generator board are made via two DIL connectors — a 24 way for the VDU and power supplies, and a 16 way for the CPU busses.

Decoding

In a minimum Nascom system the easiest way of selecting a

block of external memory is to use one of the top four address lines connected to the MEMEXT input (I shall consider A12). When the line is low the Nascom memory is selected and when it is high the Nascom is deselected. The high state can then select the external memory. This is the arrangement on the graphics board.

However, if the board is to be used in an extended system there is a good chance that a decoder with active low outputs will be in use (cf. IC36 on Nascom). There is therefore an inverter and link option to allow either polarity of select input. Once the correct polarity has been selected this input can be used to change the addresses of the RAM and allow the WR input.

The relative timing of the ends of the WR and MREQ signals from the Z80 is such that, in a minimum system with no gate delays, the MREQ signal cannot be included in the address switching. This means that the presence of a high on A12 is the only reliable way of changing the RAM addresses.

However, during input/output operations the CPU transfers information on the high order address lines so any graphics characters on the screen will assume random shapes. To overcome this a second link option allows the generator output to be blanked under these conditions by strobing the output selectors. Corruption of data is prevented by disabling the RAM when both A12 and MREQ are high.

The Board

The graphics board measures 3" x 5½" and contains both character generators, four 74LS157 data selectors, one 74LS00 address decoder and the two DIL connectors.

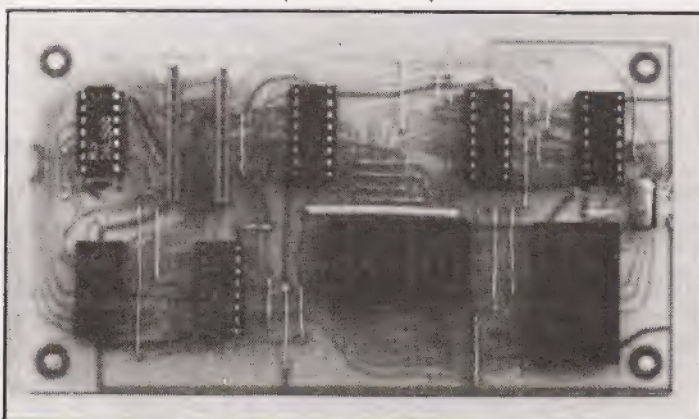
You will see that the circuit diagram is straightforward, the only problem being the link options. Read the previous section again before wiring them. The input shown as A12 should be connected to the select signal you have decided to use.

If you are connecting to a minimum Nascom remember to change the memory select link LK5 to EXT and to connect the A12 pin on the edge connector to pin 40 (MEM-EXT).

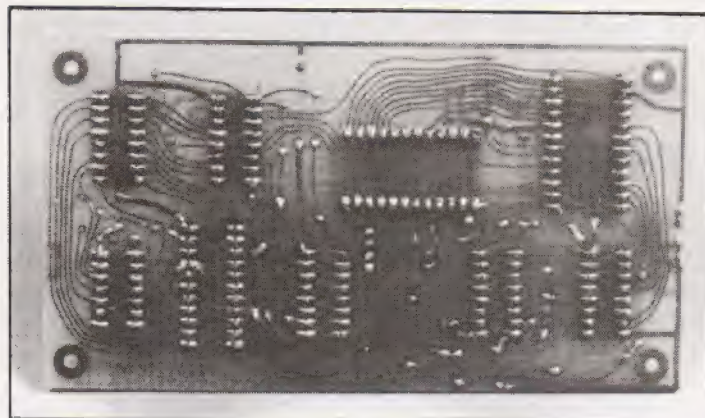
Troubleshooting

When the unit is completed check *very* carefully for shorts between the four supply lines (0, +5, -3, +12) and any other lines by examining the tracks on the board, then connect to the Nascom and switch on.

Type in some characters and observe the display. Any vertical jitter is caused by coupling in the cable to the character generator socket. Shorten this cable and if necessary use a separate cable for the row select signals to pins 21, 22, 23 and 24. Incorrect characters are probably caused by shorts on the board between inputs and outputs.



Top view of the prototype board showing links.



The copper side of the board.

The Nascom video circuit is very sensitive to the width of the shift register load pulse. This board increases that sensitivity, so if you have not already made the following modification you will have to do so now: cut the track leading to IC18 pin 5, and connect it instead to IC18 pin 12.

Put a group of characters on the top (unscrolled) line by using the Memory Modify command (M) starting at address BD0. If you enter the codes 31, 32, 33, 80, 81, 34 you should see the characters 1, 2, 3, random, random, 4. If the right hand edges of the numbers are too narrow, then the output pulse from IC18 is still too wide and this device should be replaced, preferably with a non-LS version, 74123. To alter the random graphics characters use Memory Modify at address 1000 (or whatever start address you have chosen), but remember that you cannot inspect the existing contents of this address. Enter the code F (it is only a 4 bit RAM) into 16 locations finishing at 100F. The two graphics characters should now be a complete white block. If they have not changed at all check for faulty connections to the address decoder IC7 on the graphics board. If they are not complete blocks check for shorts or bad connections around the graphics RAM.

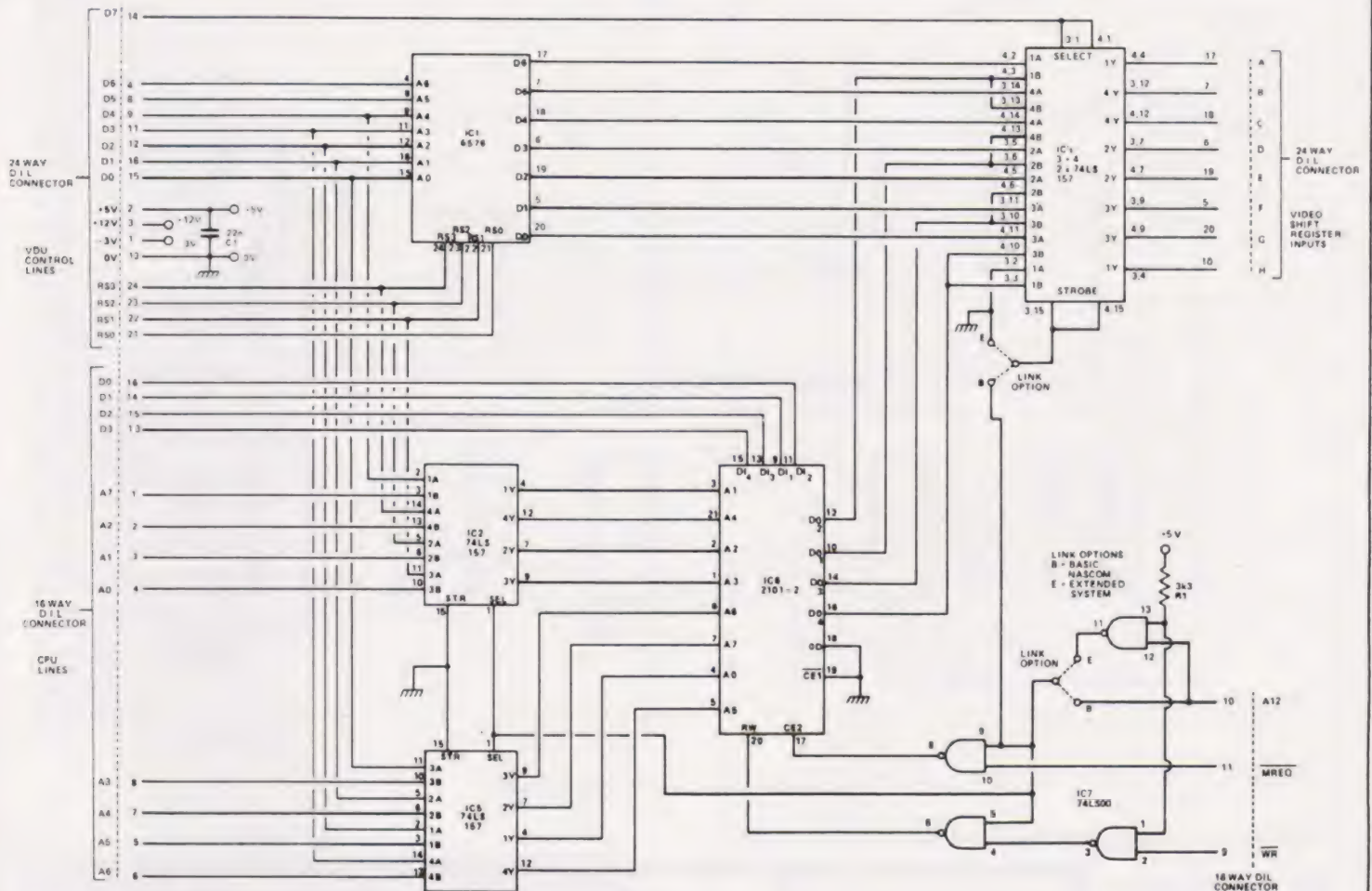
Assuming everything is satisfactory at this stage, return to address 1000 and enter 1, 2, 3, 4, etc., watching the displayed characters change as you do it. Once you are happy that you understand the operation of the circuit you can start programming your own displays on the screen.

Programming Hint

Although it is possible to allocate a byte of your program to each graphic character line and use the Block Transfer instruction 'LDIR' to load the generator this is not very efficient. Because each line only requires four bits you can combine two lines into each byte and use a small transfer routine similar to mine:

11	00	10	LD DE 1000	Graphics RAM pointer
21	**	**	LD HL (start of font)	Font pointer
06	**		LD B (length of font)	
7E			LD A, (HL)	Get one byte from font
12			LD (DE), A	Transfer 4 LSB's to RAM
1F	1F	1F 1F	RRA	4 MSB's to 4 LSB's
13			INC DE	Next graphics RAM address
12			LD (DE), A	Transfer 4 LSB's to RAM
13			INC DE	Next graphics RAM address

GRAPHICS UNIT



The circuit diagram of the graphics unit. Table 1 gives the necessary connection details.

23 INC HL Next font address
10 F4 DJNZ Do until complete

This is normally the first routine in the program and is followed by the setting of the Stack Pointer and other program parameters.

Table 1

16 way DIL socket	Nascom edge connector	Designation
1	16	Address bit 7
2	24	" " 2
3	23	" " 1
4	21	" " 0
5	18	" " 5
6	17	" " 6
7	19	" " 4
8	22	" " 3
9	26	WR
10	9 + 40 (minimum system)	Address bit 12+ MEMEXT
11	27	MREQ
13	6	Data bit 3
14	2	" " 1
15	4	" " 2
16	1	" " 0

PARTS LIST

Semiconductors

IC1	6576
IC2,3,4,5	74LS157
IC6	2101-2
IC7	74LS00

Resistors

R1	3k3
----	-----

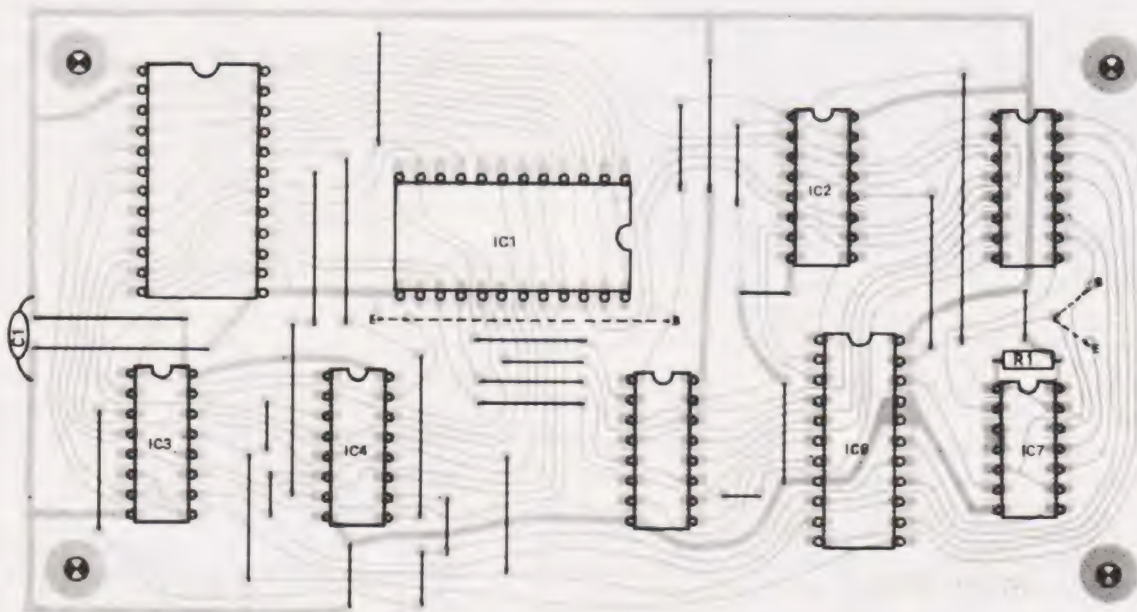
Capacitors

C1	22n
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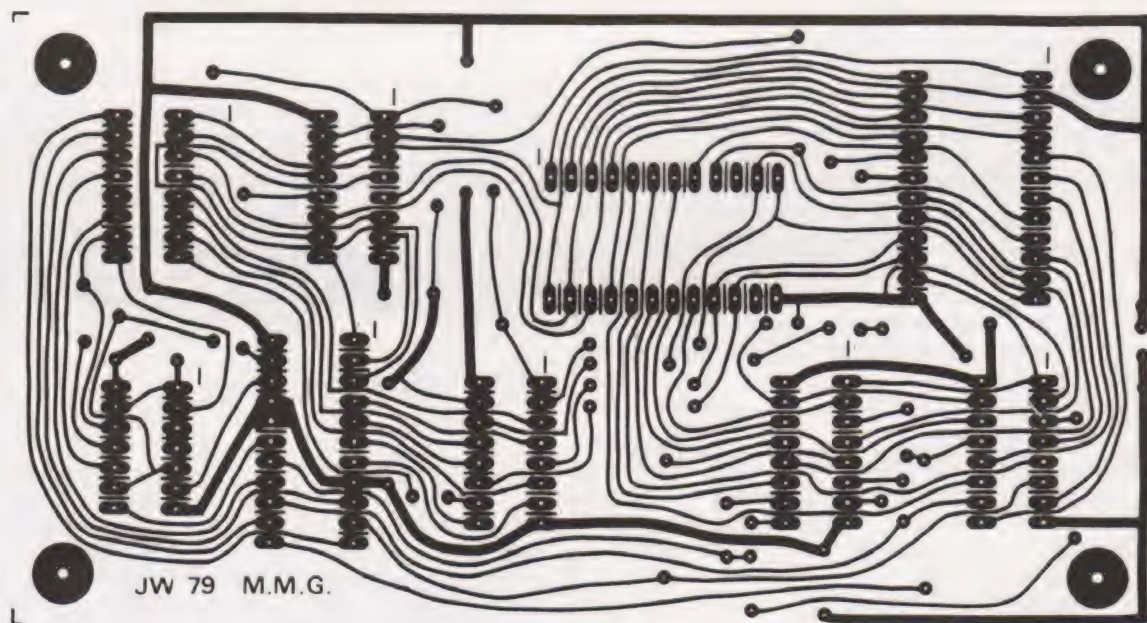
Miscellaneous

IC sockets to suit
24 way DIL connector
16 way DIL connector
PCB

GRAPHICS UNIT



The overlay pattern for the graphics unit.



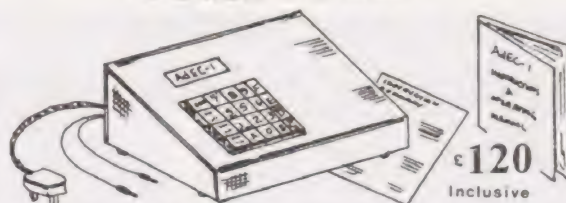
The foil pattern for the graphics unit.

A kit for this project will be available from Crystal Electronics of 40 Magdalene Road, Torquay, Devon. The price will be £30 + VAT.

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A famous game implemented on popular system, what more could you ask?

Many of you owning a NASCOM 1 will, no doubt, be tired of playing Mastermind or Hangman, and would welcome a more interesting game to play. This article is about the game of LIFE, and includes a fully assembled program listing to run on a minimum NASCOM 1.

Life was developed by John Horton Conway, a mathematician from Cambridge University. Its name comes from its resemblance to changing societies of living organisms which alter in position and number from generation to generation.

What Is Life?

LIFE can be described as a mathematical game, played on a two-dimensional board, similar to a chess board with all white squares. An initial pattern is entered on the board, and then the computer applies the basic laws of life to the pattern; Birth, Survival or Death.

Rules Of The Game

Imagine a large board containing a gridwork of squares. Each square is called a cell, and all cells are identical. Ideally, the board is infinite, but for practical purposes, it is bounded on all four sides by a border, which confines the pattern to a particular area.

Each cell can be either dead or alive, and can sense the state of its eight neighbouring cells.

After each generation, the board changes. Some cells die, some are born and some remain the same, according to these simple laws of life:

- (1) Any cell (dead or alive) which has exactly three live neighbouring cells, will be alive in the next generation.
- (2) Any cell with exactly two live neighbouring cells will remain in the same state in the next generation.
- (3) If a cell has less than two neighbours, it will die in the next generation from loneliness; if it has more than three neighbours, it will die from overcrowding.

The above rules are applied simultaneously to each cell on the board. Every cell is checked, along with its neighbours, and the fate of that cell in the next generation, is decided. This involves many thousands of checks per generation — a task ideally suited to a computer, which can compute a new generation in a fraction of a second, whereas it would take an average person with a pen and paper, at least an hour to check through the entire board once.

The Program

The program was written to run on a minimum NASCOM 1, utilising almost all of the available user RAM from 0C50 to 0FFF. The program can be split into various parts:

Routines INIT to BOTTOM generate a playing board or buffer starting at location 0E3D. A grid of cells, 24 x 15 is produced, surrounded by a border, which limits the growth of any pattern to a fixed area.

Routines SCAN to QUIT enable a pattern to be written onto the screen via the keyboard.

Routines CPYVDU to BLANK transfer the screen

contents to the buffer in RAM. For each live cell on the screen, a "1" is written into the corresponding cell in the buffer. A "0" is written for each dead cell.

The heart of the program begins at LOOP. Each cell is selected in turn and routine CHECK is called for each of its eight neighbours. CHECK tests bit 0 of each cell in the buffer. Bit 0 is the "current generation" bit in each cell. Border cells and dead cells are ignored, and the "neighbour counter" in register B is incremented for each live neighbouring cell found.

After testing the cell, the number of neighbours is determined. If three neighbours are found, bit 1 is set in the buffer cell, this being the "next generation" bit. If two neighbours are found, bit 0 is tested and copied into bit 1; if neither three nor two live neighbouring cells are found, bit 1 is reset. These operations satisfy the laws of life.

After the complete buffer has been tested, its entire contents are shifted, cell by cell, one bit to the right, by routine REGEN. The "next generation" now becomes the "current generation".

After regenerating each cell, bit 0 is tested, and if it is a "1", a ☐ is written into the corresponding screen position, by routines DEAD to LDSCRN. A blank is written if bit 0 is zero.

GEN and COUNTR deal with the generation counter. The method employed here may seem rather odd, i.e. incrementing the ASCII code for the appropriate numbers, but it works, and also takes less bytes than the conventional means of using the DECIMAL ADJUST ACCUMULATOR (DAA) instruction.

Routines MANUAL and AUTO deal with the two selectable run modes of the program, while CHOICE decides on action to be taken when the run has been terminated. Routine KEY is used extensively throughout the program, scanning the keyboard until a key is pressed.

At the end of the program are strings of ASCII text which are written into the top line of the screen. This line is non-scrolling, so it is ideal for headings and comments.

The memory from 0E3D to 0FE6 is reserved for the buffer, while the remaining RAM is used by the program stack. Extensive use has been made of labels in the program; this not only makes the listing more understandable, but allows straightforward re-assembly for those fortunate enough to have an assembler to run on their Nascom, and who would like to relocate the program. All labels external to the program i.e. monitor routines for the loader, are listed at the end of the program.

The program has been written using standard Z80 mnemonics on a Z80 assembler. All hexadecimal constants are prefixed by a "0", if the first digit is A to F, and suffixed by an "H". All other constants are decimal, and are converted to the appropriate hexadecimal object code by the assembler.

DEFB 18H assigns the value 18 (hex) to that particular byte.

DEFS 1 reserves one byte in RAM for a variable.

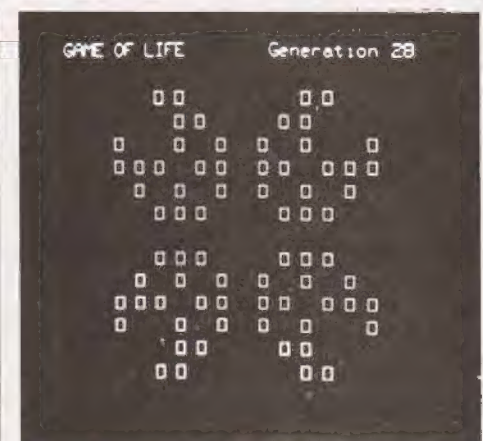
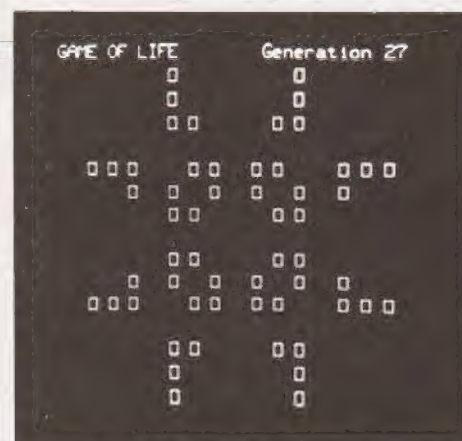
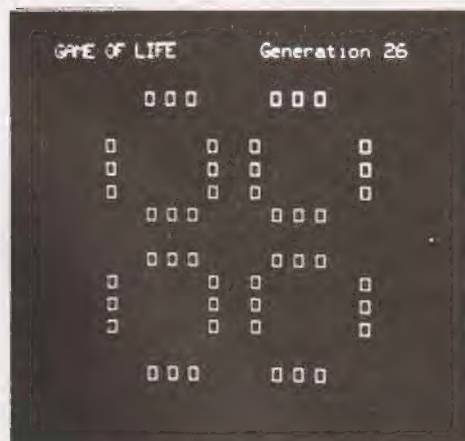
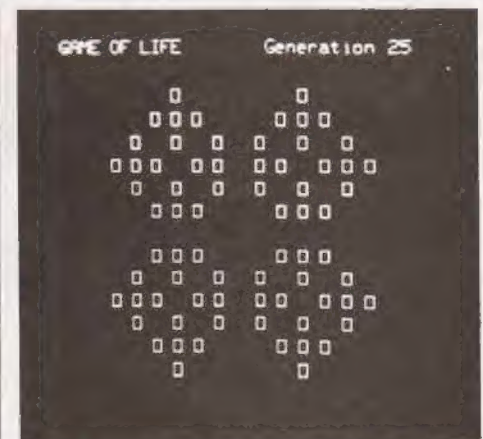
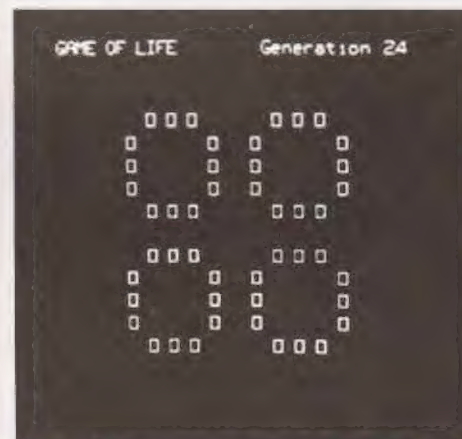
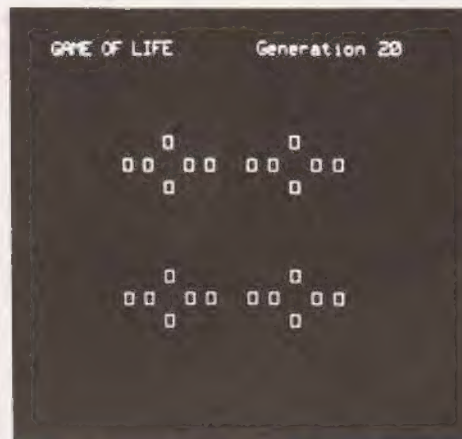
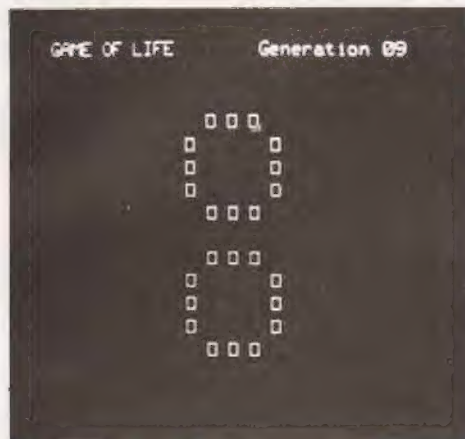
DEFM 'GAME' stores the ASCII equivalent of a string of text in quotes, in RAM.

EQU assigns a numeric value to a label.

Playing Life

Once the program has been loaded into RAM (and saved on cassette), enter EC50 "NEWLINE" to start the program. The screen should clear, and the text "GAME OF LIFE New Pattern" should appear on the top line; the cursor will be positioned at the bottom left of the screen. A pattern can now be entered via the keyboard, using any key, with the

NASCOM LIFE



The game of LIFE showing the stages taken from the insertion of a new pattern.

exception of "SPACE" "B/S" and "NEWLINE", which provide the normal functions, "R" which restarts the loader if a mess has been made of the pattern, or "Q" which quits input mode and awaits further instructions.

Having entered the pattern, (and making sure that it is as near to the centre of the screen as possible), press "Q", and the text on the top line should change to "Manual/Auto, to which the reply can either be "A" which immediately enters auto mode, or "M" for manual mode. In auto mode, the generations are computed one after another. Due to the large amount of cell testing involved in the program, it takes approximately 0.2 seconds to compute and display a new generation so in auto mode, the pattern changes five times a second, which fortunately happens to be fast enough to give a continuously changing display, yet slow enough to be able to observe the individual steps without having to introduce any extra delay loops into the program. This mode is ideal for tried and tested patterns, however for new patterns, it is always best to use manual mode. In this mode, pressing any key (except "A" or "Q") will single-step the program a generation at a time, enabling easy analysis of users' patterns.

During auto mode, if "M" is pressed, manual mode is selected; likewise during manual mode, control can be transferred to auto mode by pressing "A". During both modes, the generation number is updated at the top of the screen, which is a very useful feature for keeping track of new patterns. Pressing "Q" quits run mode, and the text "New/Continue?" is written on the top line. The user then has the choice of "C" to continue the run, or "N" to clear the screen, and enter a new pattern.

When entering large patterns, make sure that they are as centrally positioned on the screen as possible, otherwise one edge of the growing pattern may hit the border before the other edge, and either symmetry will be lost, or the pattern will take a totally different course, and maybe even die out completely.

I would be interested to hear from readers who have tried this program and have discovered some new and interesting patterns, or ideas on improving the program.

Life is a very addictive game. Once hooked, it is all too easy to stay up to the early hours of the morning trying to invent the "ultimate pattern".

NAME OF LIFE	LOC	ORG CODE	STMT	SOURCE	LIFE LISTING 17/8/79	PAGE 1
					ASM 1.1	
0050			1	*H NAME OF LIFE : Written by M.Kuczyński 1979		
0050	213030		2	ORG 0050H		
0053	22140E		3	START: LD HL,3030H ;3030 = ASCII *00*		
0056	01		4	LD (NUMBER),HL ;RESET COUNTER		
0057	00		5	RST 40 ;CLEAR THE SCREEN		
0058	00		6	DEFC 10H ;IE = *CLEAR* CODE		
0059	00		7	DEFC 0 ;00 = END OF ROUTINE		
0059	110000		8	LD DE,0000H ;TOP LINE OF SCREEN		
005A	210000		9	LD HL,TITLE ;*NAME OF LIFE*		
005B	010000		10	LD RC,13 ;NUMBER OF LETTERS		
005C	0000		11	LD RC,13 ;WRITE TITLE		
005D	210000		12	INTT: LD HL,BORDER ;START OF BORDER		
005E	0000		13	LD B,25 ;CELLS IN TOP BORDER		
005F	0000		14	LD C,15 ;NUMBER OF ROWS		
0060	38FF		15	TOP: LD HL,00FFH ;WRITE TOP BORDER		
0061	21		16	INC HL ;NEXT CELL		
0062	1000		17	LD HL,100		
0063	38FF		18	LD HL,00FFH ;REPEAT UNTIL END		
0064	21		19	LD HL,00FFH ;WRITE LEFT BORDER		
0065	21		20	INC HL ;NEXT CELL		
0066	0000		21	LD B,24 ;CELLS PER ROW		
0067	00		22	INC HL ;WRITE BLANK CELL		
0068	1000		23	LD HL,100		
0069	00		24	DEC B ;LAST ROW ?		
006A	20F3		25	LD NZ,LL1T ;NEXT ROW		
006B	001A		26	LD B,26 ;CELLS IN BOTTOM BORDER		
006C	38FF		27	BOTTOM: LD HL,00FFH ;WRITE BOTTOM BORDER		
006D	21		28	INC HL ;NEXT CELL		
006E	1000		29	LD HL,100		
006F	110000		30	HEADER: LD DE,0000H ;MIDDLE OF TOP LINE		
0070	211A0E		31	LD HL,NEWPTN ;*NEW PATTERN*		
0071	010000		32	LD RC,13 ;NUMBER OF LETTERS		
0072	0000		33	LD RC,13 ;WRITE COMMENT		
0073	0000		34	SCAN: CALL KEY ;KEY PRESSED ?		
0074	0000		35	CP 1FH ;NEW LINE ?		
0075	004002		36	LD NZ,00 ;TEST FOR *B/S*		
0076	10F4		37	CALL PR1F ;SCROLL PAGE		
0077	0000		38	LD NZ,00 ;NEXT CHARACTER		
0078	0000		39	CP 10H ;BACKSPACE ?		
0079	0000		40	LD NZ,SPCT ;TEST FOR *SPACE*		
007A	0000		41	CALL BACKSP ;BACKSPACE CURSOR		
007B	0000		42	LD NZ,00 ;BACKSPACE CURSOR		
007C	0000		43	LD NZ,00 ;NEXT CHARACTER		
007D	0000		44	CP 20H ;SPACE ?		
007E	0000		45	LD NZ,QUIT ;TEST FOR *QUIT*		
007F	0000		46	CALL SPACE ;ADVANCE CURSOR		
0080	0000		47	CALL SPACE ;ADVANCE CURSOR		
0081	0000		48	LD NZ,00 ;NEXT CHARACTER		
0082	0000		49	CP 21H ;QUIT ?		
0083	0000		50	LD NZ,RUN ;GO TO RUN MODE		
0084	0000		51	CP 22H ;RESTART ?		
0085	0000		52	LD NZ,START ;RETURN TO START		
0086	0000		53	LD HL,(CURSOR) ;CURSOR POSITION		
0087	0000		54	LD HL,(HL),00H ;FILL IN CELL		
0088	0000		55	INC HL ;NEXT CELL		
0089	0000		56	LD (CURSOR),HL ;SAVE CURSOR POSITION		
008A	0000		57	LD SPCE1 ;NEXT CHARACTER		
008B	0000		58	LD DE,0000H ;MIDDLE OF TOP LINE		

NAME OF LIFE	LOC	ORG CODE	STMT	SOURCE	LIFE LISTING 17/8/79	PAGE 1
					ASM 1.1	
008C	300A		59	OUTT: LD A,AUTO ;JUMP=1		
008D	3000		60	LD HL,00 ;WRITE DISPLACEMENT		
008E	111A0E		61	LD HL,00 ;MIDDLE OF TOP LINE		
008F	210000		62	LD HL,RUNSTR ;*GENERATION XX*		
0090	010000		63	LD RC,13 ;NUMBER OF LETTERS		
0091	0000		64	LD RC,13 ;WRITE COMMENT		
0092	2A180E		65	CPY000: LD HL,(CURSOR) ;CURSOR ADDRESS		
0093	3020		66	LD HL,(HL),20H ;REMOVE CURSOR		
0094	210000		67	LD HL,0000H ;TOP OF SCREEN		
0095	11070E		68	LD DE,BORDER ;START OF BOARD		
0096	00		69	LD A,(HL) ;TEST CELL		
0097	00		70	LD A ;END OF SCREEN ?		
0098	0000		71	LD NZ,RUN MODE ;GO TO RUN MODE		
0099	0000		72	LD NZ,00 ;TEST CELL		
009A	0000		73	LD NZ,00 ;TEST IF NOT END		
009B	0000		74	LD NZ,00 ;SAVE NEIGHBOURS		
009C	0000		75	LD NZ,00 ;LINE OFFSET		
009D	0000		76	LD NZ,00 ;PASS OFFSET TO LINE		
009E	0000		77	LD NZ,00 ;RESTORE REGISTERS		
009F	0000		78	LD NZ,00 ;NEXT CELL		
00A0	0000		79	LD NZ,00 ;REPEAT TO END OF LINE		
00A1	0000		80	LD NZ,00 ;LIVE CELL ?		
00A2	0000		81	LD NZ,00 ;RETEST IF DEAD		
00A3	0000		82	LD NZ,00 ;*LIVE CELL		
00A4	0000		83	LD NZ,00 ;WRITE CELL ON BOARD		
00A5	0000		84	LD NZ,00 ;NEXT SCREEN POSITION		
00A6	0000		85	LD NZ,00 ;NEXT BOARD POSITION		
00A7	0000		86	LD NZ,00 ;NEXT CELL		
00A8	0000		87	LD NZ,00 ;*0* = DEAD CELL		
00A9	0000		88	LD NZ,00 ;WRITE CELL ON BOARD		
00AA	0000		89	LD NZ,00 ;START OF BOARD		
00AB	0000		90	LD NZ,00 ;NUMBER OF CELLS		
00AC	0000		91	LD NZ,00 ;CLEAR NEIGHBOUR COUNTER		
00AD	0000		92	LD NZ,00 ;BORDER CELL ?		
00AE	0000		93	LD NZ,00 ;IGNORE IT		
00AF	0000		94	LD NZ,00 ;TEST CELL TO NORTH-WEST		
00B0	0000		95	LD NZ,00 ;CHECK IF ALIVE		
00B1	0000		96	LD NZ,00 ;TEST CELL TO NORTH		
00B2	0000		97	LD NZ,00 ;CHECK IF ALIVE		
00B3	0000		98	LD NZ,00 ;TEST CELL TO NORTH-EAST		
00B4	0000		99	LD NZ,00 ;CHECK IF ALIVE		
00B5	0000		100	LD NZ,00 ;TEST CELL TO WEST		
00B6	0000		101	LD NZ,00 ;CHECK IF ALIVE		
00B7	0000		102	LD NZ,00 ;TEST CELL TO EAST		
00B8	0000		103	LD NZ,00 ;CHECK IF ALIVE		
00B9	0000		104	LD NZ,00 ;TEST CELL TO SOUTH-WEST		
00BA	0000		105	LD NZ,00 ;CHECK IF ALIVE		

NAME OF LIFE	LOC	ORG CODE	STMT	SOURCE	LIFE LISTING 17/8/79	PAGE 2
					ASM 1.1	
00BB	0000		106	LD NZ,00 ;TEST CELL TO SOUTH		
00BC	0000		107	LD NZ,00 ;CHECK IF ALIVE		
00BD	0000		108	LD NZ,00 ;TEST CELL TO SOUTH-EAST		
00BE	0000		109	LD NZ,00 ;CHECK IF ALIVE		
00BF	0000		110	LD NZ,00 ;LOAD NEIGHBOUR COUNTER		
00C0	0000		111	LD NZ,00 ;THREE NEIGHBOURS ?		
00C1	0000		112	LD NZ,00 ;IF NOT, TEST FOR TWO		
00C2	0000		113	LD NZ,00 ;CELL WILL BE ALIVE		
00C3	0000		114	LD NZ,00 ;NEXT CELL		
00C4	0000		115	LD NZ,00 ;TWO NEIGHBOURS ?		
00C5	0000		116	LD NZ,00 ;IF NOT, TEST NEXT CELL		
00C6	0000		117	LD NZ,00 ;IS CELL ALIVE ?		
00C7	0000		118	LD NZ,00 ;CELL WILL STAY ALIVE		
00C8	0000		119	LD NZ,00 ;NEXT CELL		
00C9	0000		120	LD NZ,00 ;DECREMENT CELL COUNTER		
00CA	0000		121	LD NZ,00 ;ARE ALL CELLS TESTED ?		
00CB	0000		122	LD NZ,00 ;IF NOT, TEST NEXT CELL		
00CC	0000		123	LD NZ,00 ;NUMBER OF CELLS		
00CD	0000		124	LD NZ,00 ;TOP OF SCREEN		
00CE	0000		125	LD NZ,00 ;START OF BOARD		
00CF	0000		126	LD NZ,00 ;NUMBER CELL ?		
00D0	0000		127	LD NZ,00 ;IF NOT, REGENERATE		

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The complete program listing with both source and object codes. As can be seen the program is bug free!

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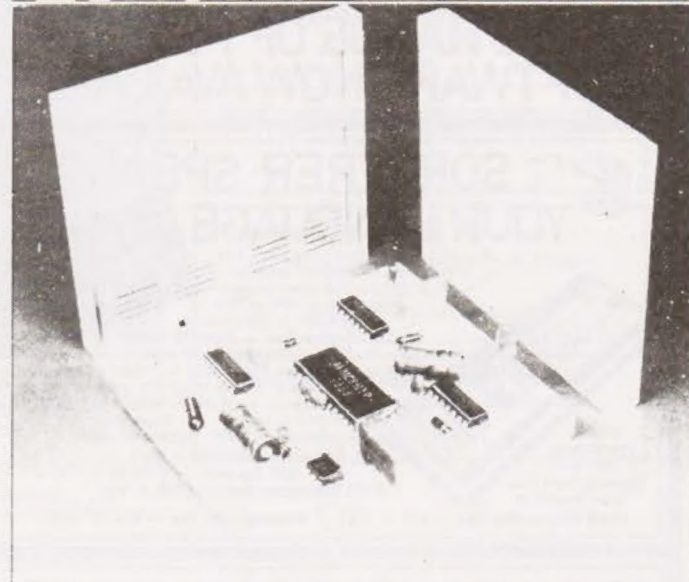
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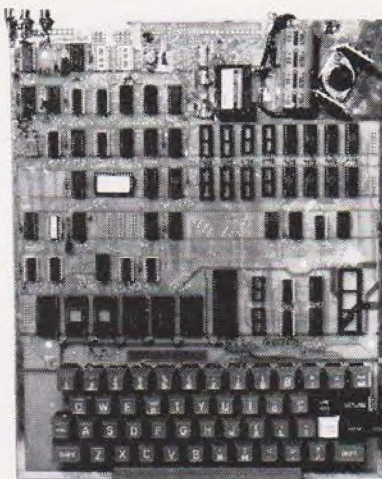
COMMANDS
CONT LIST NEW NULL RUN
STATEMENTS
CLEAR DATA DEF DIM END FOR
GOTO GOSUB IF GOTO IF THEN INPUT LET
NEXT ON GOTO ON GOSUB POKE PRINT READ
REM RESTORE RETURN STOP

EXPRESSIONS

OPERATORS
+ - * / % NOT AND OR > < >= <= RANGE 10⁻³² to 10⁺³²

VARIABLES

A.B.C. ... Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus \$ e.g. A\$.



*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print. **SPECIAL CHARACTERS**

@ Erases line being typed, then provides carriage return, line feed.

Erases last character typed.

CR Carriage Return — must be at the end of each line.

Separates statements on a line.

CONTROL/C Execution or printing of a list is interrupted at the end of a line.

"BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.

CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.

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FUNCTIONS

ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)
FRE(X)	INT(X)		
SGN(X)	SIN(X)		
USR(I)			

STRING FUNCTIONS

ASC(X\$)	CHR\$(I)	FRE(X\$)	LEFT\$(X\$,I)
RIGHT\$(X\$,I)		STR\$(X)	
LEN(X\$)	MID\$(X\$,I,J)		
VAL(X\$)			

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